Canada - Ontario
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Agreement

Entente
Canada - Ontario
sur l'exploration minérale

IN-SITU DETERMINATION OF DEWATERED TAILINGS FILL PROPERTIES IN ONTARIO MINES

CANMET SCIENTIFIC AUTHORITY: ALFRED ANNOR

March 31, 1988 - Revised March 1990

Canada

Ontario

[redacted]

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Final Report
by: Denis Thibodeau
INCO Mines Research

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Executive Summary

A contract was issued to INCO through the Canada-Ontario Mineral Development Agreement in collaboration with CANMET to encompass the in-situ determination of dewatered tailings fill properties in Ontario mines.

The project had three main objectives:

1- To outline and develop a quantitative understanding of the in-situ support and fill properties of high density dewatered sand paste fill. This was achieved by using in-situ instrumentation (pressure cells, convergence monitors, piezometers etc) and by constant monitoring with dataloggers. It was found that the fill could withstand a wide pressure range from 200 psi to 1000 psi and still act as a very stable support. The behaviour of the fill under load was studied. It was found that arching and the elastic beam theory could not be applied since the principal stresses in the fill were much larger than the maximum fiber stress calculated. The principal stresses were believed to be caused by pillar convergence. This closure resulted in the pillar ore trying to fill up the newly created mined area under the fill mass. This resulted in a crushing action.

2- To relate laboratory determined fill properties to those observed in-situ. The comparison between the laboratory cylinders and the in-situ samples shows different ranges of results for different tests. The in-situ samples had a uniaxial compressive strength 86% higher, a moisture content 15% lower, and a unit weight 2% lower than the test cylinders.

A cement reduction of 36% was achieved with a strength increase of 160% compared to 10:1 hydraulic backfill at 70% density.

3- Provide CANMET with two 3 inch diameter holes through the in-situ fill. These boreholes will be used to test and monitor the fill with a pressuremeter.

The collective results of this research program should allow for a better understanding of the forces at work on a fill mass. This in turn should result in better stope design, more efficient use of binder products and safer ground support.

Further research incorporating numerical modelling of a fill mass and the adjacent surrounding rock would complete this goal.

Sommaire

Un contrat a été donné à INCO Limitée pour déterminer le comportement sous pression et les propriétés d'un remblai à haute densité.

Le projet comportait trois étapes distinctes qui formaient un tout. La première étape consistait à déterminer les propriétés du remblai en testant en laboratoire des cylindres coulés en surface et sous terre. La deuxième étape avait pour but d'enregistrer les réponses du remblai quand on minait sous celui-ci. Ceci a été effectué en utilisant de l'équipement électronique placé dans le remblai lui-même. La troisième étape consistait à recouvrer dans le chantier d'abattage des échantillons du remblai consolidé et de les tester en laboratoire pour comparer les résultats avec ceux obtenus des cylindres.

L'analyse des résultats du programme d'enregistrement des réponses du remblai a permis de conclure que les pressions principales latérales étaient trop fortes pour associer le comportement du remblai a un phénomène d'arquage d'une poutre élastique simple soumise à pression uniformément distribuée. Les fortes pressions latérales seraient causées par le rapprochement des murs du chantier d'abattage.

Les résultats d'analyse des cylindres et des échantillons prélevés sur place ont été comparés pour trouver la relation entre les deux types d'analyse. Il a été trouvé que le remblai placé sous terre avait: une résistance en compression uniaxialle 86% plus grande, un taux d'humidité 15% plus petit et une masse spécifique 2% plus petite que les résultats obtenus des cylindres.

Une augmentation de la résistance en compression uniaxialle de 160% associée avec une réduction en ciment de 36% comparée à un remblai hydraulique avec un rapport d'agrégat au ciment de 10:1 et une densité de 70%, a également était observé.

Les résultats obtenus grâce à ce projet de recherche permettront, avec de plus amples recherches et l'application du modelage numérique, de développer de meilleures configurations des chantiers d'abattage et d'associer la quantité de ciment du remblai aux résistances en compression désiré

1- Introduction

One of the major concerns of the Canadian mining industry is to improve production while maintaining high safety standards. To achieve such a goal, Canadian mining companies in association with the federal and provincial governments are currently involved in extensive technological research. Mine Backfill is one major area of this joint venture. Research is directed at producing a superior product at the lowest possible cost.

As a result of INCO's initial test work with high density fill, a contract was issued to INCO through the Canada-Ontario Mineral Development Agreement in collaboration with CANMET to encompass the in situ determination of dewatered tailings fill properties in Ontario mines. INCO high density fill was successfully placed underground on 700 level at Levack Mine. The fill, a pumpable mix of well graded alluvial pit run sand, portland cement, water and -325 mesh tailings slimes was mixed in a surface pilot plant and pumped underground. A standard concrete pump was used to transport the fill product at a pulp density of 80 to 85 weight percent solids.

Project objectives:

1) To outline and develop a quantitative understanding of the in-situ support and fill properties of a high density dewatered sand paste fill.

2) To relate laboratory determined fill properties to those observed in-situ.

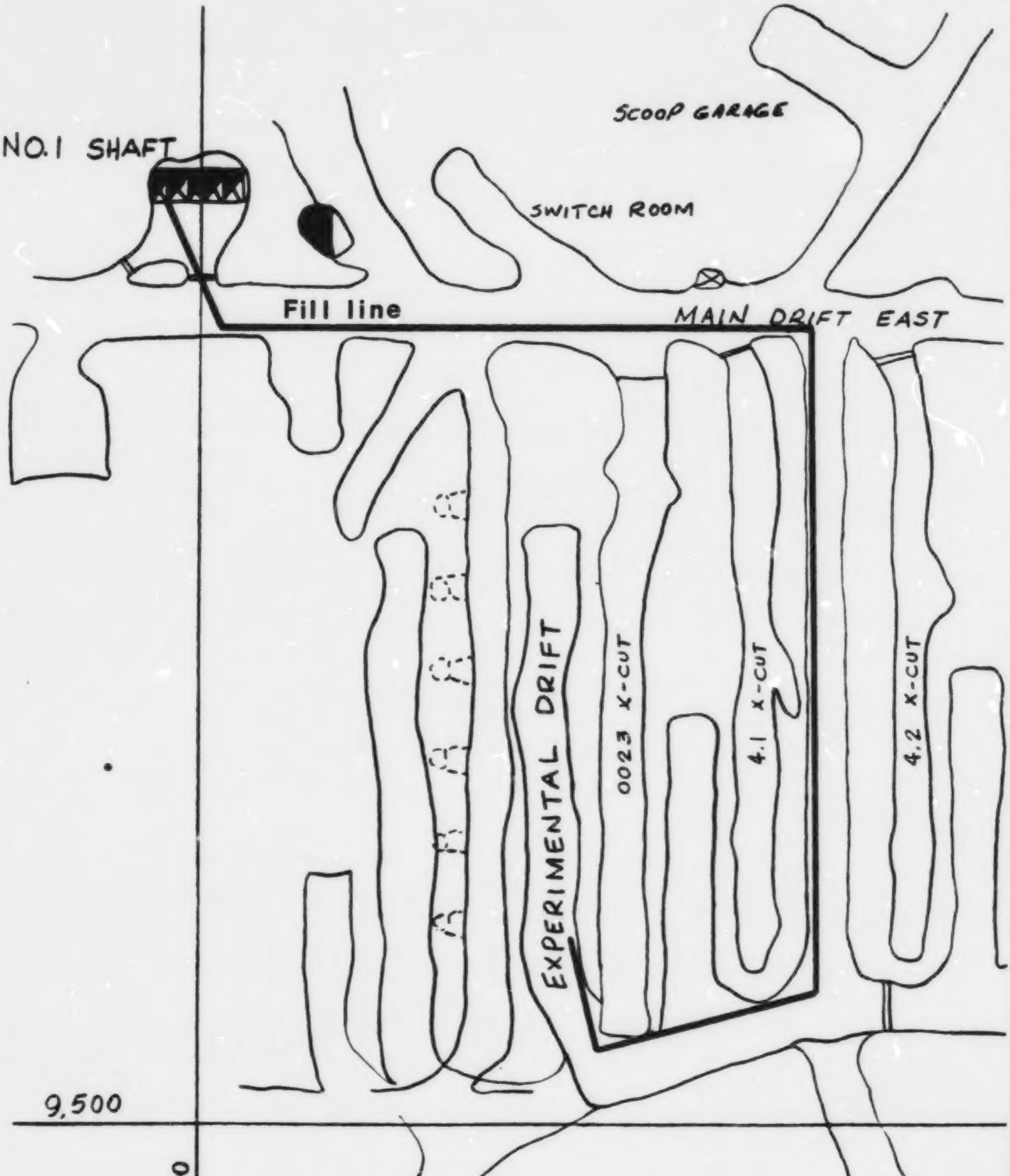
3) To provide CANMET with two 3 inch diameter holes through the in-situ fill. These boreholes will be used to test and monitor the fill with a pressuremeter.

The project was divided into six different tasks:

1) Select a suitable workplace at Levack Mine. In April 1986 the slices 2WA and 2WB in the 9600 block on the 900 level were chosen (figs. 1 and 2)

2) Mine out the cut to be filled.

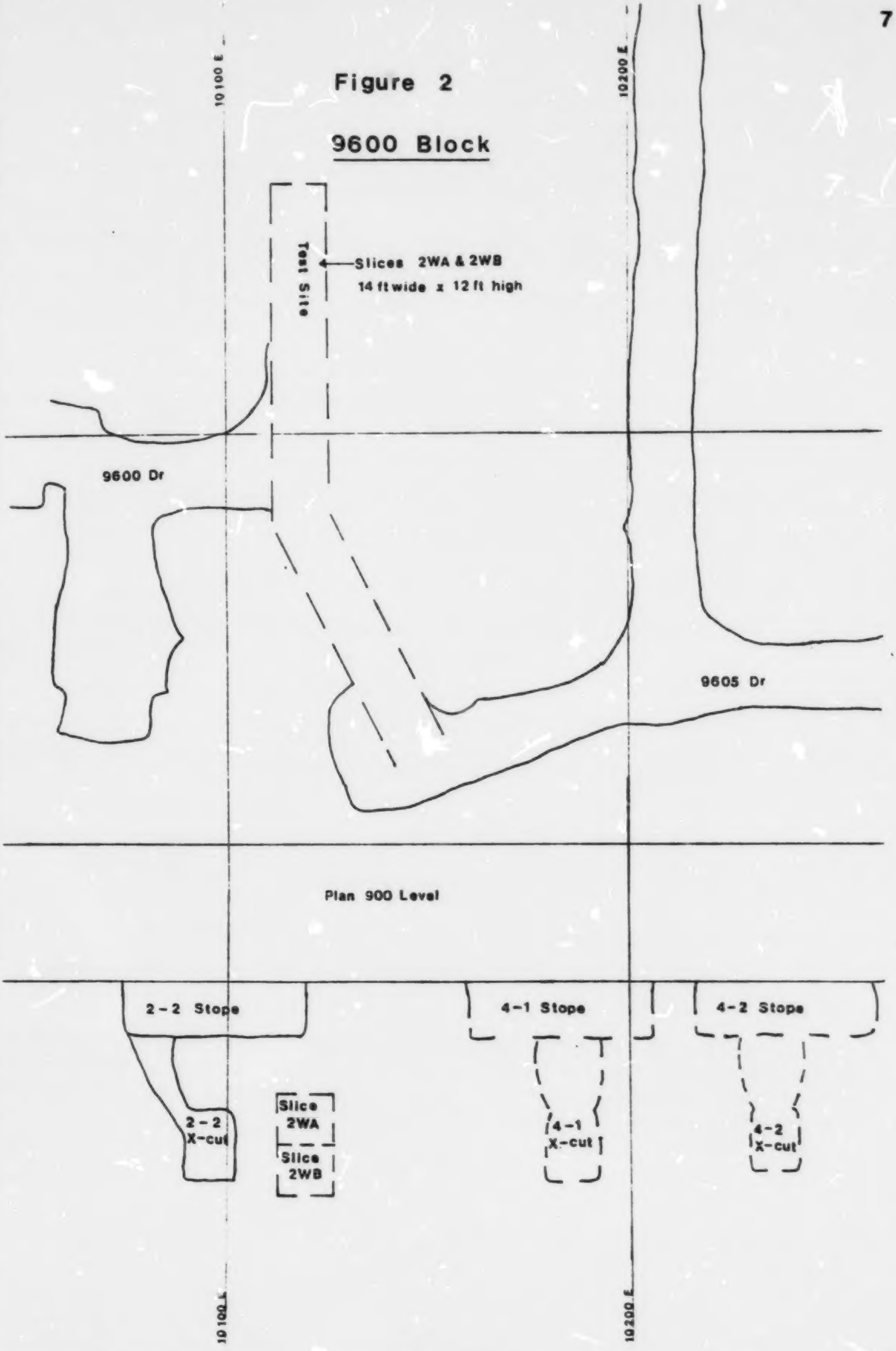
Figure 1


SCOOP GARAGE
NO.1 SHAFT
SWITCH ROOM
Fill line
MAIN DRIFT EAST
EXPERIMENTAL DRIFT
0023 X-CUT
4.1 X-CUT
4.2 X-CUT
9,500
10,000

Levack 900 Level Test Site

Figure 2

9600 Block


10100 E
10200 E
Test Site
Slices 2WA & 2WB
14 ft wide x 12 ft high
9600 Dr
9605 Dr
Plan 900 Level
2-2 Stope
4-1 Stope
4-2 Stope
2-2 X-cut
Slice 2WA
Slice 2WB
4-1 X-cut
4-2 X-cut
10100 E
10200 E

3) Install instrumentation to monitor ground movement and pressure in the fill.

4) Fill the workplace with pumped paste fill and determine the material properties of the fill and its components.

5) Undercut the filled area and collect in situ samples for property determination.

6) Report the findings.

This report first describes the equipment and the procedure used to complete the above tasks.

The results are divided into three different categories:

1) Laboratory results from test cylinders.

2) Results from monitoring in situ instrumentation.

3) Results obtained from in situ sampling of the fill.

It was assumed that the in-situ behaviour of the fill under load will correspond to arching. Using elastic beam theory, the data obtained from the monitoring program is analyzed and evaluated to see if it fits the chosen model.

Furthermore, the in-situ results were compared to the laboratory results to determine if using test cylinders is a good way to evaluate fill characteristics.

From the in-situ fill properties an assessment of the cement content was carried out to see if an effective reduction in the cement content of 60% had been achieved, in conjunction with a reduction in water content.

The results obtained provide a better understanding of fill properties. It is believed that this will permit a more cost-effective determination of fill requirements for different mining methods as well as improving safety.

2- Equipment and Procedure

The pilot plant at Levack Mine consisted of the following equipment: (fig. 3)

- Two slimes holding tanks (maintained at a density of 60% by weight solids).
- One SRL pump.
- One 25 ton cement silo with roto-lock feeder.
- One screened hopper with belt feed.
- One Schwing BP250 concrete pump.
- One front end loader.

Paste fill material was prepared by mixing tailings, Type 10 portland cement, slimes and water in the screw mixer. The operator achieved a continuous pumping efficiency with practice. The Schwing pump had a maximum capacity of 40 tons per hour.

A site at Levack Mine (located 50 km northwest of Sudbury) on 900 level was selected as an undercut-and-fill application. A geological description of the Levack ore body is given in Appendix "G".

The first step was to mine out slice 2WA (see figs. 2 and 4) and fill it. Prior to filling the stope, instrumentation was placed in the mined-out area. Filling began in September 1986 and was completed in April 1987 (filling had to be interrupted on several occasions because of delays in delivery of the instrumentation).

Appendix "D" contains a detailed description of the procedures used for fill room preparation and for pouring of the fill.

The in-situ measuring instruments consisted of 36 total earth pressure cells (see fig. 4) , 3 piezometers, 2 Young's modulus cells, 4 thermistors and 7 convergence monitors. In addition, partitioned plywood boxes (for an alternate source of in-situ sample recovery) were also placed in the hanging wall sector.

Figure 3

PROTOTYPE HIGH-DENSITY PASTE FILL SYSTEM

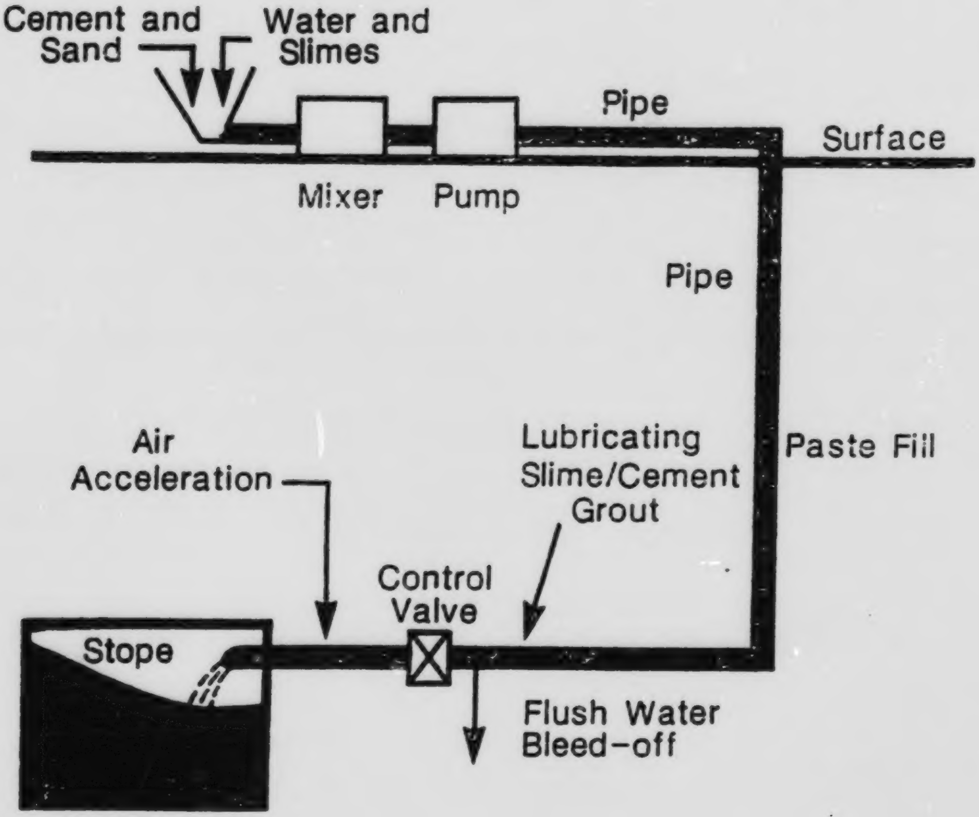
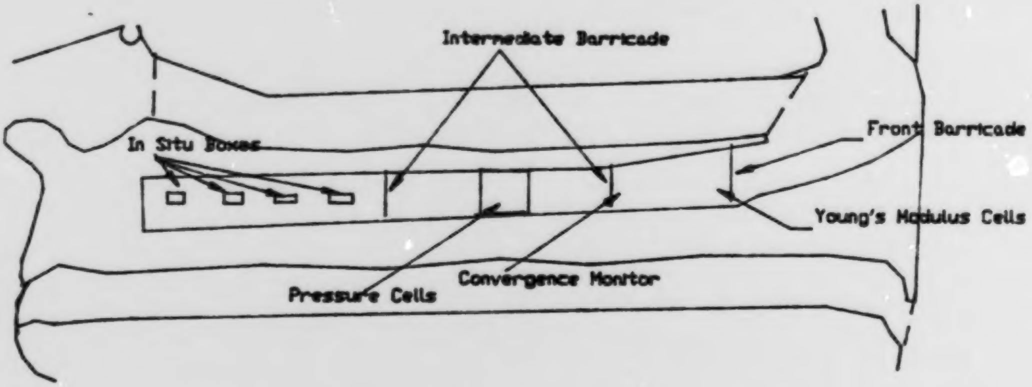
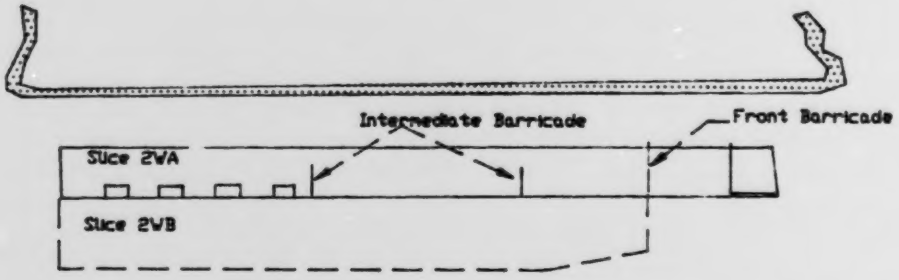

Cement and Sand
Water and Slimes
Pipe
Surface
Mixer
Pump
Pipe
Air Acceleration
Lubricating Slime/Cement Grout
Paste Fill
Control Valve
Stope
Flush Water Bleed-off

FIGURE 4
9600 BLOCK - 900 LEVEL LEVACK MINE


Intermediate Barricade
In Situ Boxes
Front Barricade
Young's Modulus Cells
Convergence Monitor
Pressure Cells

PLAN VIEW


Intermediate Barricade
Front Barricade
Slice 2WA
Slice 2WB

LONG SECTION

Samples of the fill product were taken in both 6 and 2 inch diameter cylinders on surface and at the pour point. Analyses were made to determine:

- Size distribution.
- Mineral content.
- Portland content (if applicable).
- Moisture content.
- Bulk density.
- Compressibility modulus.
- Uniaxial compressive strength.

Similar tests were performed on in-situ samples after the undercut was mined out.

The instrumentation was connected to three Terra-8 data acquisition systems to allow for continuous monitoring while the filled slice 2WA was being undercut.

The data from the data acquisition systems was downloaded on a regular basis during the mining of slice 2WB to identify stress changes in the self-supporting fill.

The mining of undercut 2WB was completed on November 26, 1987. Monitoring of the filled area 2WA was to be continued for another six months.

Shortly after the completion of mining slice 2WB, Trow Ltd. was contracted to drill 3 inch pressuremeter holes for CANMET and recover in situ samples of 6 and 3 inch cores. A crew was sent underground to retrieve core samples. The operation met with limited success as only three samples were recovered and tested. These included one 6 and two 3 inch diameter samples. Three plywood boxes that were placed in the fill for such an eventuality were recovered and sent to Trow for testing. Attempts were made to drill three inch diameter core out of the boxes. Only one of six attempts proved successful. As a last resort, seven 2 inch side cubes were cut out of the boxes and tested for uniaxial compressive strength. For a more detailed report on the problems encountered during the in-situ coring see appendix A.

3- Results and Discussion

3.1- Laboratory Results

All the cylinders poured and cast were sent to Trow Ltd. in Sudbury for testing in order to determine the properties of the paste fill.

Tests were performed to determine the uniaxial and triaxial compressive strengths of the fill. Break tests were done at 7, 28, 168 and 183 days. In addition, wet density, dry density and moisture content of each sample was determined.

A total of forty 6 inch diameter samples and forty-nine 2 inch diameter cylinders were tested. The main results are summarized in Tables 1 and 1A. Appendix B contains the detailed results for each sample. Figures 5 and 6 show the failure envelopes for 7 day and 28 day cured samples respectively. Figure 12 gives the grain size distribution of the fill. Table 2 gives the chemical analysis of the high density fill.

Table 1

Fill Properties Determined from Test Cylinders

Porosity: 15.9% (2 samples)

Specific Gravity:
sand: 2.75 (4 samples)
slimes: 2.60
portland: 3.15
mix: 2.74 (4 samples)

Average Pulp Density: 89.72% solids by weight (s=1.29%) (63 samples)

PH: 10.54

Average Cement Content: 4.6% (15 samples)

Average Moisture Content of the Mix: 12.33% (s=2.6%) (63 samples)

Average Moisture Content of the Sand: 4.1% (4 samples)

Average Wet Unit Weight: 137.2 lbs/c.f. (s=3.92 lbs/c.f.) (63 samples)

Average Dry Unit Weight: 122.25 lbs/c.f. (s=5.11 lbs/c.f.) (63 samples)

Average Compressive Strength:

Confining pressure (psi)		0	25	50	100
7 days	Compressive strength (psi)	186	360	406	568
	Standard deviation	48	137	92	101
	Number of samples	14	4	4	4
28 days	Compressive strength (psi)	236	355	596	660
	Standard deviation	131	101	210	281
	Number of samples	8	6	8	6
168 days	Compressive strength (psi)		478	498	510
	Number of samples		2	2	2
183 days	Compressive strength (psi)		475	700	725
	Number of samples		1	1	1

Table 1A - Young's Modulus Results

Average Young's Modulus

Confining Pressure (psi):	0	25	50	100
7 Days Young's Modulus (ksi)	68	38	32	41
Standard deviation	41	16	19	10
Number of samples	14	4	4	4
28 Days Young's Modulus (ksi)	62	36	53	56
Standard deviation	26	22	30	22
Number of samples	8	7	7	6
168 Days Young's Modulus (ksi)		44	28	36
Number of samples		2	2	2
183 Days Young's Modulus (ksi)		52	82	62
Number of samples		1	1	1

Permeability: 0.79 inch/hour (2 samples)

Void Ratio: 0.189 for the paste (1 samples)

Failure Envelope (see fig. 5 and 6)

7 days: cohesion = 51.63 psi
angle of internal friction = 32.5 degrees (23 samples)

28 days: cohesion = 75.93 psi
angle of internal friction = 32.5 degrees (20 samples)

Note: (s stands for standard deviation)

Table 2
Test Cylinders Chemical Analyses
(Results in %)

Cylinders Number and Date Poured	Cu	Ni	Co	Fe	S	SiO_2	Al_2O_3
16 (March 5)	.027	.0333	.0043	4.57	.169	63.8	13.2
16	.031	.0375	.0044	4.30	.191	65.4	13.0
13	.052	.0566	.0046	4.89	.291	64.1	13.2
10 7th	.060	.0717	.0054	5.00	.352	62.2	13.1
12 7th	.064	.136	.125	4.91	.211	64.0	13.2
14 (March 5)	.054	.0675	.0052	4.89	.357	61.8	12.6
15	.030	.0447	.0053	4.44	.208	61.9	13.0
6	.033	.0523	.0051	5.13	.303	62.2	13.2
2 (March 3)	.030	.0463	.0047	4.61	.226	62.9	13.1
2 (March 3)	.029	.0389	.0040	4.65	.192	62.5	13.3
2 (March 3)	.033	.0518	.0044	4.85	.273	60.6	12.9
17 (March 9)	.074	.0906	.0058	5.39	.525	60.5	12.7
18	.062	.0776	.0060	5.37	.408	62.1	13.3
20	.036	.0414	.0048	4.46	.249	63.8	13.3
20	.041	.0736	.0081	4.62	.248	63.3	13.2

	Ba	CaO	Cr_2O_3	K	MgO	Mn	TiO_2
16 (March 5)	.0414	5.16	.0231	2.08	2.66	.0583	.469
16	.0397	5.23	.0236	2.03	2.38	.0537	.433
13	.0410	5.03	.0245	2.01	2.59	.0593	.478
10 7th	.0426	5.04	.0279	2.17	2.76	.0588	.462
12 7th	.0422	4.95	.0233	2.09	2.54	.0582	.475
14 (March 5)	.0444	5.39	.0252	1.97	2.63	.0575	.449
15	.0418	5.38	.0263	2.07	2.52	.0559	.447
6	.0399	5.16	.0267	1.93	2.90	.0641	.504
2 (March 3)	.0396	5.02	.0271	2.01	2.62	.0584	.448
2 (March 3)	.0440	4.99	.0241	2.07	2.72	.0589	.468
2 (March 3)	.0395	5.57	.0273	1.96	2.84	.0608	.478
17 (March 9)	.0389	5.97	.0295	1.91	2.97	.0630	.475
18	.0408	5.58	.0284	1.99	2.97	.0639	.498
20	.0462	4.94	.0236	2.30	2.42	.0548	.452
20	.0443	5.39	.0472	2.19	2.52	.0552	.444

Figure 5

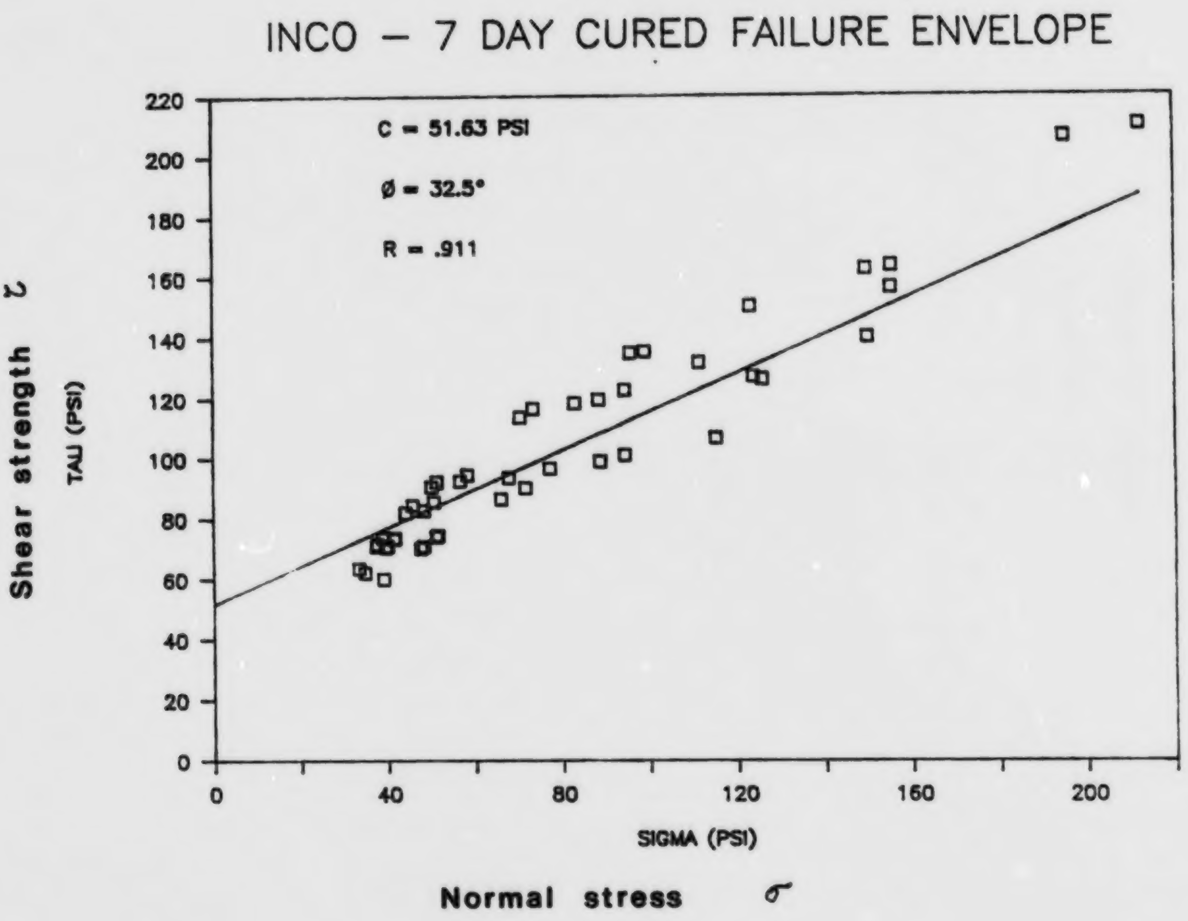

INCO – 7 DAY CURED FAILURE ENVELOPE
C = 51.63 PSI
Ø = 32.5°
R = .911
220
200
180
160
140
120
100
80
60
40
20
0
TAU (PSI)
Shear strength τ
0
40
80
120
160
200
SIGMA (PSI)
Normal stress σ

Figure 6

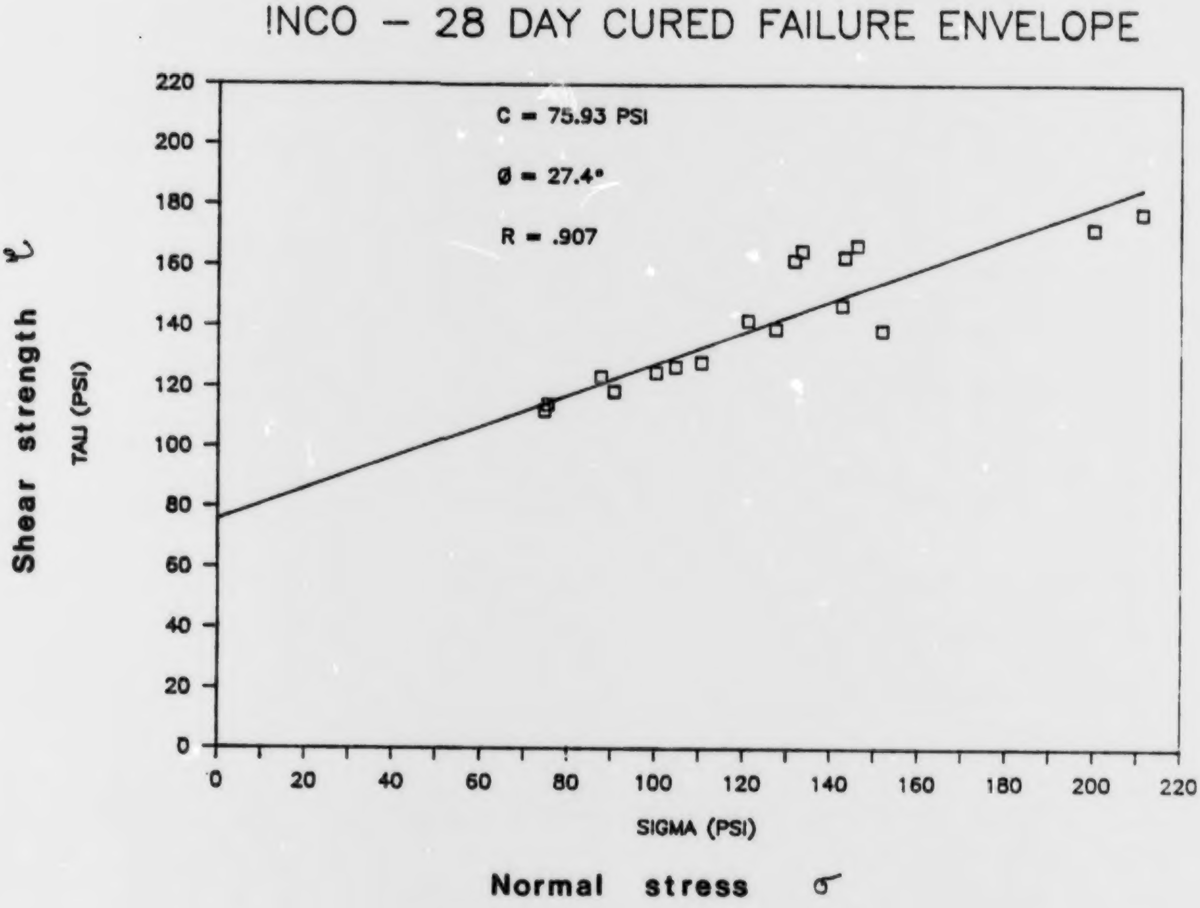
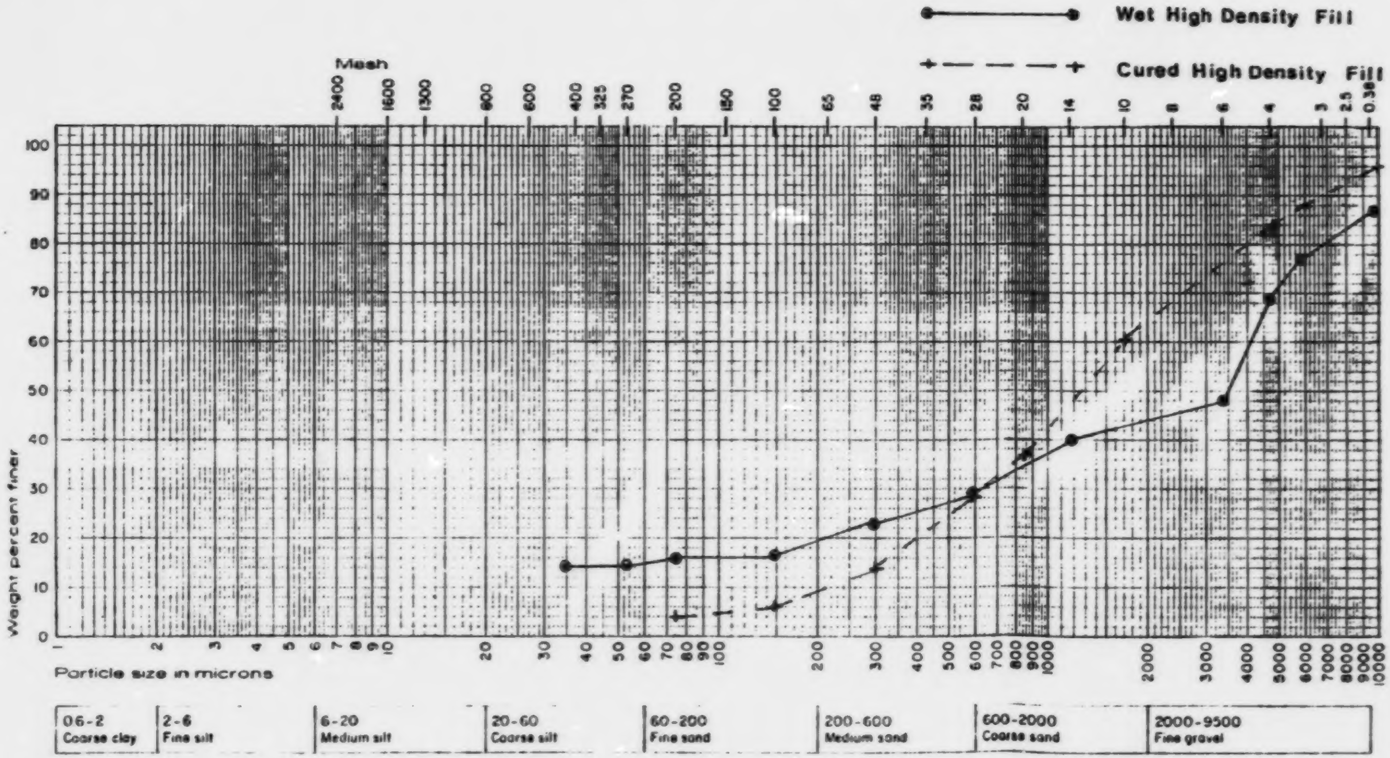

INCO – 28 DAY CURED FAILURE ENVELOPE
C = 75.93 PSI
Ø = 27.4°
R = .907
220
200
180
160
140
120
100
80
60
40
20
0
TAU (PSI)
Shear strength τ
0
20
40
60
80
100
120
140
160
180
200
220
SIGMA (PSI)
Normal stress σ

Figure 12

Fill Grain Size Distribution



3.2 - In-Situ Monitoring Program

Data was collected on an hourly basis and the daily average was compiled. The data obtained and the related graphs are included in Appendix C. Appendix E contains information about the events that took place during the monitoring period.

3.2.1- Earth Pressure Cells

The cells were oriented in five different positions. Appendix E contains information on the layout of the monitoring instrumentation (Table 4 gives the cells number and their specific orientation within the stope,and Figures 7 to 11 give the position of all the instruments in the stope).

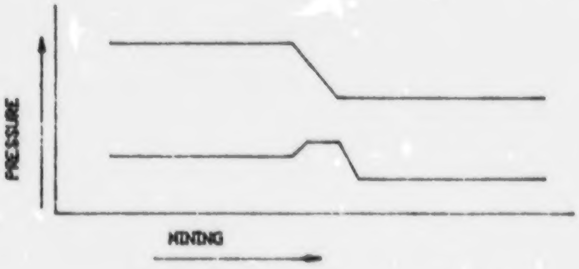
Before proceeding with the analyses of the pressure cell readings, a definition of arching should be given since it is assumed that the fill will display an arching behaviour. **Arching** can be defined as "the lateral transfer of a gravitational load to the support, rather than vertically as transverse loading". More specifically, arching is the process of lateral load distribution associated with friction mobilized between the surfaces of the upper beams. (Brady and Brown).

Figure 13 shows a schematic representation of the cell response as mining progressed. The horizontal cells only registered gravity load. Therefore, if arching effects were present, a decrease in the pressure reading should be observed. The vertical cells will have a range of different responses depending on their positions with respect to the height of the stope; for example, the top cells will have a pressure increase, the middle cells will stay constant and the bottom cells will show a pressure drop. The maximum pressure change in vertical cells will be registered by the cells parallel to the length of the stope. The 45 degree cells parallel to the stope should react in a similar manner to the vertical cells. The 45 degree cells perpendicular to the stope should have a similar response to the horizontal cells.

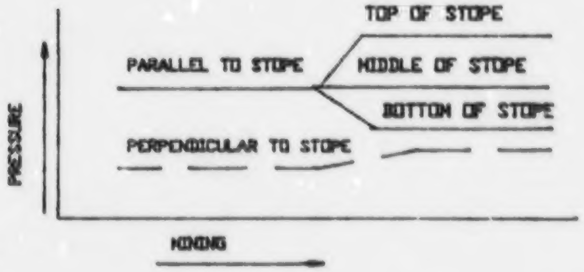
Observed Pressure Cell Behaviour

From the results obtained, the first observation to be drawn is that a certain number of cells were defective and did not register valid information. The cells in question are: 187, 188, 198, 203, 204, 216.

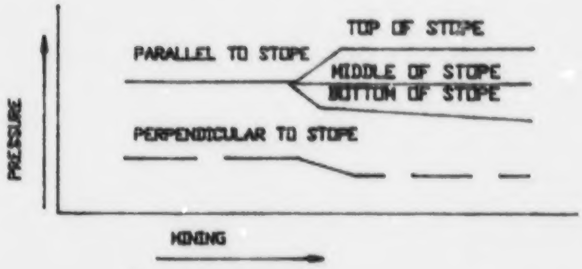
FIGURE 13: CELL THEORETICAL RESPONSE TO ARCHING



HORIZONTAL CELL



VERTICAL CELL



45 DEGREE CELL

The earth pressure analysis can be divided into five categories according to the respective orientations within the stope.

The horizontal cells,excluding cell 184, showed a constant pressure throughout the mining period until the work face was beyond the cell location (after October 30) at which time a progressive and slow decrease in pressure occurred. This suggests a lateral redistribution of the gravity load.

The vertical cells parallel to the stope maintained a constant response to the load until mining proceeded beyond their location. Once that happened, the pressure applied onto the cells near the top of the stope increased, but stayed constant for the cells in the middle of the stope. The pressure decreased after mining was completed.

The vertical cells perpendicular to the stope maintained a constant pressure throughout the mining period, or displayed a slight increase after the mining proceeded past the cell positions. After mining was completed the pressure readings decreased.

The cells with a 45 degree inclination and parallel to the stope had a response similar to the vertical cells parallel to the stope. This similarity ended after mining when the load applied remained constant.

The cells inclined at 45 degree and perpendicular to the stope had a constant pressure throughout mining or displayed a response similar to that of the horizontal cells (ie. a pressure drop after mining was beyond the cell location due to the gravity load being redistributed laterally).

Most of the cells registered a load distribution pattern corresponding to the cell theoretical response to arching, (ie. gravity load being redistributed laterally as mining advances.), but as will be shown later, the increased lateral load had nothing to do with arching.

3.2.2- Convergence Monitors

Seven convergence monitors were installed in the stope: three horizontally across the stope (pots 184,185,188), one horizontally along the stope (pot 190), and three vertically (pot 186,187,189).

The maximum movement registered was a horizontal increase of 2.8 inches in pots 184 and 188 and of 2.75 inches in the vertical pot 186; the other convergence monitors reflected little change.

The expected response of the convergence monitors to arching is as follows: The horizontal convergence monitor perpendicular to the stope, situated in the lower part of the fill mass, would be subjected to tension and therefore would be elongated. The same monitor placed in the upper part of the fill would be subjected to compression and would therefore contract. The vertical monitor should be elongated from the fill mass movement. The horizontal monitor parallel to the stope should stay constant.

From the three vertical monitors only one was elongated and the other two stayed at the same length. This partly indicates arching since elongation was expected from the monitors, but at least no contraction was registered, therefore the results are still within the theoretical response for arching.

From the three horizontal convergence monitors perpendicular to the stope, only one had the expected response, pot 184, which was in the tension part of the fill and was elongated. Pot 185 remained constant which could be due to the fact that it is situated near the neutral axis of the fill mass. Pot 188 does not agree at all with the theory; it should have been contracted and was elongated instead.

The fact that the monitors readings suddenly jump from three inches to six inches could suggest that they were short circuited when mining occurred directly underneath them. Therefore the results registered with the convergence monitors are probably false and should not be regarded as valid.

The horizontal convergence monitor parallel to the stope, pot 190, was elongated by one inch which is the maximum deformation expected from the fill according to the laboratory Young's modulus.

3.2.3- Thermistors

The thermistors showed a constant reading throughout the mining period. This could mean one of two things: either the temperature was constant throughout the experiment, or the thermistors were not operational, which is the most likely explanation.

3.2.4- Piezometers

The results obtained from the piezometers showed a very low water pressure in the fill prior to August 6, 1987, and a dry fill thereafter. This was to be expected since the fill was poured between September 1986 and April 1987, giving plenty of time for the fill to drain itself before measurement of water pressure was started in July 1987. The water pressure that was observed could have been caused by drainage water migrating from another stope being filled with hydraulic backfill.

3.2.5- Youngs Modulus Cells

Numerous problems were encountered with the Youngs modulus cells. Firstly, the temperature sensor and the pressure transducer were non-operational from the beginning of monitoring. The cells gave some response, and from the pressure applied with the manual hydraulic pump, an estimate of the fill Youngs modulus was calculated. The LVDT cells were improperly calibrated.

Cell 207 gave an average Youngs modulus over the mining sequence of 279.01 ksi with 19 measurements, and cell 208 yielded an average value of 211.40 ksi with 9 measurements, for an overall average of 257.34 ksi (with a standard deviation of 91.00 ksi). Appendix C gives detailed results of the transducer response.

3.2.6- Beam Theory Discussion

The results obtained from the in-situ monitoring program will be used to see if the elastic beam theory could be applied to the behaviour of the fill mass.

Appendix "F" contains the detailed calculations (using the Beam Theory) used to obtain the principal stresses σ_1, σ_2 and σ_3.

Table 5 gives a summary of the results, and figure 17 displays the results at the corresponding location in the stope.

Table 5

Principal stresses within the fill mass

Reference line	height (ft)	σ_1 (psi)	σ_2 (psi)	σ_3 (psi)	θ_{12}
A	9	1003.6	331.4	1058.0	-10.3°
A	5	435.3	327.7	1086.1	34.9°
B	6	782.4	399.6	786.1	- 8.5°
C	3	1338.0	343.0	1337.5	25.0°

Note: maximum **fiber stress** was calculated (Appendix "F") as 11.67 psi.

It is obvious from the above results that the load carried by the fill is much larger than what was accounted for in the beam theory. Hence the stresses due to arching within the beam theory are negligeable quantity compared to the principal stresses measured in the fill.

It is assumed that as the slice 2WB was mined, loads that were supported by the ore had to be redistributed, and part of this was taken by the rock mass enclosing the fill and by the fill mass itself. Figure 18 schematically illustrates this phenomena; wall closure of the stope, induced shear within the fill mass, and an increase of the lateral stress (σ_1) carried by the fill mass. With a Poisson effect, the increased lateral stress will increase the vertical stress.

Using the results of the failure envelopes of figure 5 and 6 ($c = 63.5$ psi and $\phi = 30^\circ$) Co and q can be calculated with the following formulas:

$$Co = 2(c) \tan \left(45 + \frac{\phi}{2}\right) = 219.7 \text{ psi}$$

$$q = \left[\tan \left(45 + \frac{\phi}{2}\right)\right]^2 = 3$$

where Co = cohesion factor and q = factor of internal friction.

A plot of a σ_3 versus σ_1 graph (figure 19) shows that the fill mass is very near failure. This means that the lateral stresses are so high that the fill would be squeezed into place and crushed to the point where failure would occur.

FIGURE 18 STRESS INDUCED BY WALL CLOSURE

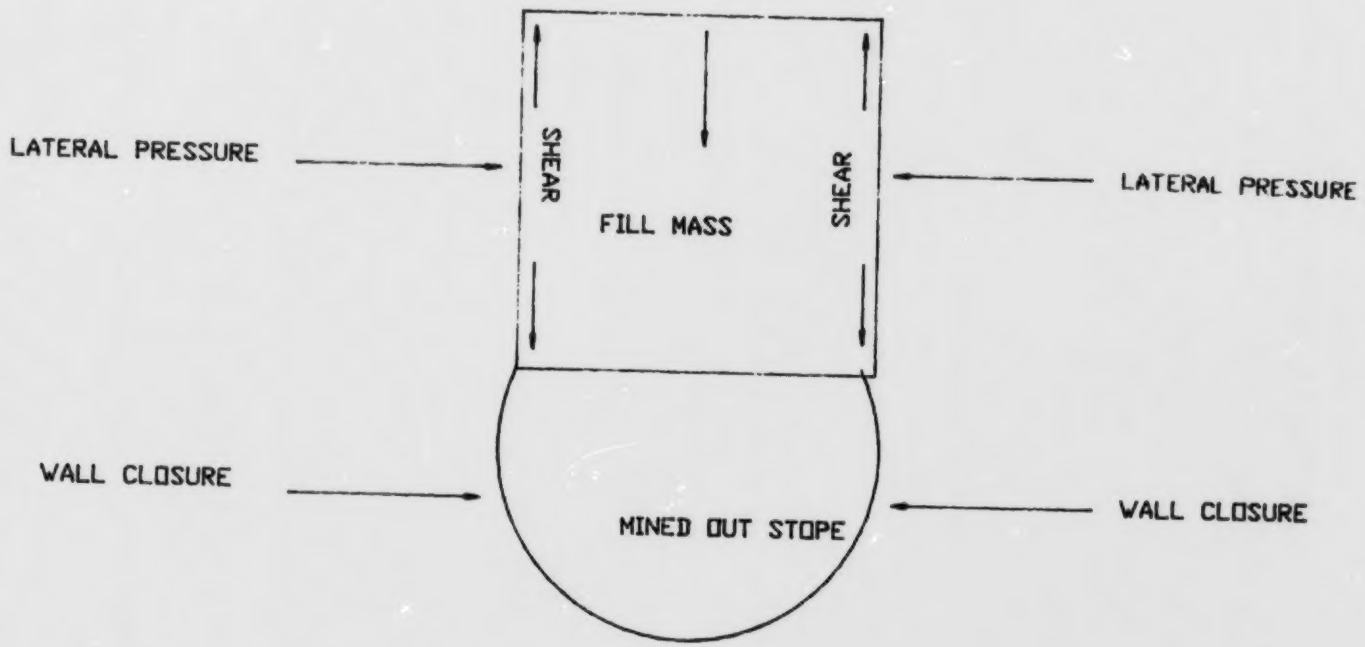
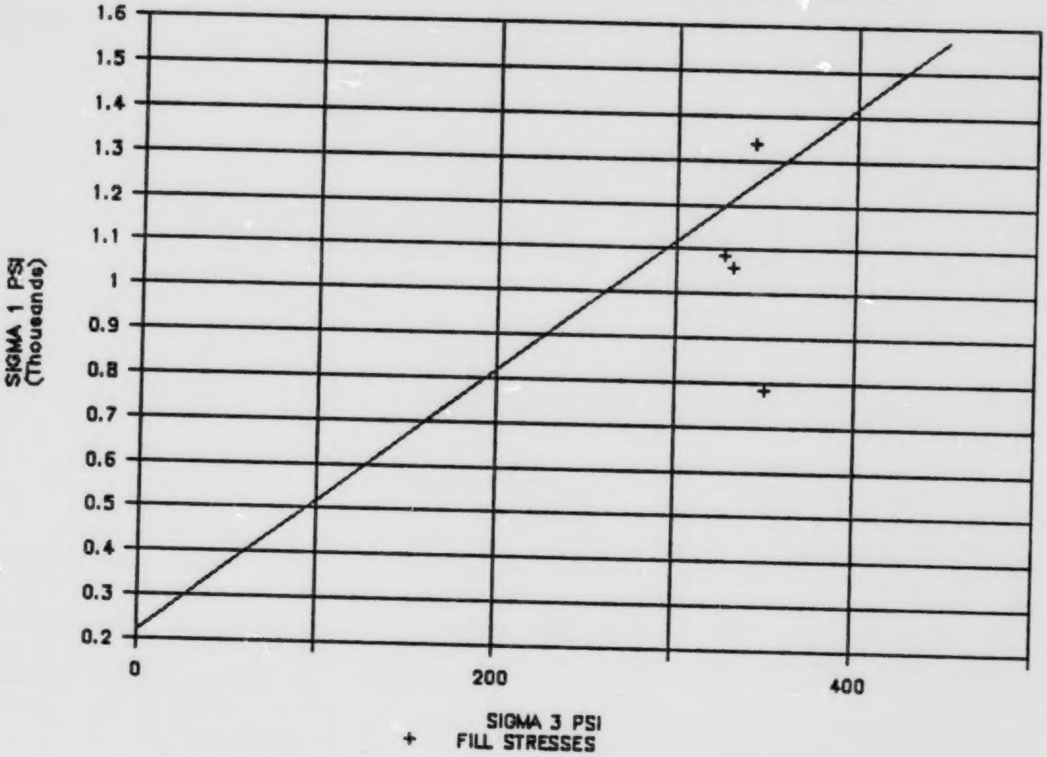

LATERAL PRESSURE
SHEAR
FILL MASS
SHEAR
LATERAL PRESSURE
WALL CLOSURE
MINED OUT STOPE
WALL CLOSURE

FIGURE 19 FILL FAILURE ENVELOPE



3.3- In-Situ Sampling

The in-situ sampling program, was not very successful and only a few samples were recovered. Plywood boxes were buried in the fill mass, and were subsequently excavated and sent to Trow Ltd. in Sudbury for testing. Trying to extract core samples from these boxes turned out to be too difficult. Therefore, seven 2" cubes were tested for uniaxial compressive strength. Table 7 summarizes the results obtained from the in-situ sampling program. Figure 12 shows the grain size distribution of the fill.

3.3.1- In-Situ Moisture Content

The average in-situ moisture content is 10.6%, a reduction of 14% compared to the laboratory result. The in-situ samples were taken from the bottom of the fill slab at the front and at the back of the stope.

3.3.2- In-Situ Cement Content

The results from table 6 yield a value of 6.42% which corresponds to a sand to cement ratio of 16:1. The laboratory results yielded a value of 4.6% or a 21:1 ratio. A uniaxial compressive strength of approximately 400 psi was achieved. A 10:1 hydraulic backfill contains 10% cement and has uniaxial compressive strength in the range of 150 psi (INCO past testing), an effective cement reduction of 36% was realized. The strengths obtained are much higher than those of hydraulic backfill. If hydraulic backfill is used as a standard, the cement content of high density fill could be reduced even further.

3.3.3- Compressive Strength

The uniaxial compressive strength at 28 days of the eight test cylinders yielded an average value of 236 psi, while the 6 inch diameter (by 15 inch high) core sample produced a value of 435 psi (84% higher than the laboratory results). The 3 inch cores with strengths of 235 and 230 psi fell within the range of the test cylinders.

Table 6
In-Situ Samples Chemical Analyses
(Results in %)

In-Situ Sample	Cu	Ni	Co	Fe	S	SiO_2	Al_2O_3	Ba	CaO	Cr_2O_3	K	MgO	Mn	TiO_2
K2199	.106	.0867	.0057	5.63	.355	59.4	11.5	.0379	6.42	.0328	1.56	2.58	.0621	.450

Table 7

In Situ Sampling Program Results

Average moisture content: 10.6% (s=0.49%) (2 samples)

Average wet unit weight: 135.26 lbs/c.f. (2 samples)

Average dry unit weight: 121.46 lbs/c.f. (2 samples)

Cement content: 6.42% (1 sample)

Average void ratio: 0.323 (2 samples)

Compressive Strength (0 psi confining pressure)

Samples	Strength (psi)
6 inch core from stope	435
3 inch core #1 from stope	230
3 inch core #2 from stope	235
2.78 inch core from boxes	405
Cube #1	520
Cube #2	819* (large stone present)
Cube #3	575
Cube #4	250
Cube #5	300
Cube #6	526
Cube #7	447
Overall average	428
3 inch core average	290
Cube average	491

Young's modulus (0 psi confinement)

Average for cubes: 10.10 ksi (S=5.94 ksi) (7 samples)

6 inch core from stope: 75 ksi
3 inch core #1 from stope: 12 ksi
3 inch core #2 from stope: 26 ksi

3.3.4- Young's Modulus

After 28 days with 0 psi confining pressure the average of 8 samples yielded a value of 162.44 ksi, while the 6 inch diameter core had a value of 75 ksi (which is 54% lower than the laboratory results).

The in-situ Young's modulus cells yielded an average value of 257.34 ksi, which is 58% more than the 28 day average value and 3.43 times more than that of the six inch diameter core samples. One of the problems encountered with the cells is the fact that they were not adequately calibrated prior to their installation, and therefore did not perform properly. Some further research and development is necessary before a reliable instrument can be used to measure in-situ Young's modulus of backfill.

3.3.5- Unit Weight

The average in-situ unit weight of the fill was 135.26 lbs/ft^3. This value is similar to the laboratory result of 137.20 lbs/ft^3. The average dry unit weight of the fill was 121.46 lbs/ft^3 (which is 0.65 less than the laboratory result of 122.25 lbs/ft^3).

3.3.6- Void Ratio

The in-situ void ratio of 0.323 is up 70% compared to the laboratory void ratio of 0.189.

4- Conclusion

The principal objectives of this project were to evaluate in- situ properties and in-situ behaviour under load of a high density fill.

To obtain pertinent information concerning the in-situ properties of the fill mass, cylinders were poured both at the underground placement point and on surface, and were subsequently tested in laboratory. Furthermore, in-situ samples were taken and tested after the stope was mined out. The comparison between the test cylinders and the in-situ samples shows that in terms of uniaxial compressive strength, the in-situ samples yielded a value 86% higher than that of the test cylinders. This means that the test cylinder results are conservative compared to those of the in-situ fill. The cylinder results for moisture content and unit weight agree within + 15% and - 2% respectively with those of the in-situ samples.

The Young's modulus results from the test cylinders were within 54% of the in-situ results from the sampling program and within 58% of the Young's modulus monitoring program. It is very difficult to determine the true Young's modulus value of the fill since the Young's modulus cells were poorly calibrated and also because the in-situ sampling program was not entirely successful. Nevertheless, a review of the laboratory results from both the test cylinders and the in-situ samples shows that the Young's modulus of the fill falls between 50 and 100 ksi.

The total earth pressure cells were laid out in a pattern that would permit analysis of the arching behaviour of the fill. It was found from the in-situ stress results that the fill mass did not behave according to the expected elastic beam theory with arching. The in-situ pressures measured within the fill were too high to agree with the elastic beam theory. Therefore, it was anticipated that by mining underneath the fill, closure of the side walls was induced, which produced increased lateral pressures in the fill mass.

As a follow-up to this report, numerical modeling should be done to gain more knowledge of the fill mass behaviour under load. This would be interesting since the failure envelope suggested that the fill was near failure.

The chemical analysis of the in-situ samples revealed that the sand to cement ratio was about 15:1, which is a 35% reduction in cement compared to 10:1 hydraulic backfill at 70% density. Also, the strength achieved was 160% higher than that of hydraulic backfill, which suggests that more tests with a lower cement content are warranted.

While mining was progressing it was observed that the fill was of high quality throughout the entire slice. The fill was competent and it performed very well by providing a very straight and solid back for a timberless undercut and fill application. There was no need to install any additional support within the stope to keep the fill in place while mining. This represents a direct increase in productivity.

This behaviour was anticipated based on the results from laboratory tests performed on the high density fill. The high average uniaxial compressive strength obtained after 28 days (about 200 psi) points out the high quality of the placed fill. This was confirmed by the in-situ sample results which yielded an average uniaxial compressive strength of 428 psi.

The main problem encountered with the in-situ monitoring system was the delay encountered in the delivery of equipment. This did not allow the instrumentation to be calibrated before being installed in the test area. As a result, "bugs" had to be taken out of the system while the experiment was already in progress.

Overall, the project demonstrated the possibility and the advantages of using high density fill in a timberless undercut-and-fill application. It clearly brought about a better understanding of the behaviour of high density fill placed under load, and produced a better understanding of high density fill properties. This understanding, along with further research, will allow for better stope design and also allow for the adjustment of cement content of the fill according to the strength requirements needed to improve safety, and obtain optimum ground support. Additional work might involve the modelling of the response of the fill mass to excavations made in the vicinity of the backfilled area.

5- References

1- Brady, B.H.G. and Brown, E.T.: Rock Mechanics for Underground Mining, George allen & Unwin, London, 1985, 527 pages.

2- Hidgon, A. et al.: Mechanics of Material, John Wiley & Sons, New York, 1985, Fourth Edition, 744 pages.

Canada - Ontario
Mineral Development
Agreement

Entente
Canada - Ontario
sur l'exploration minérale

IN-SITU DETERMINATION OF DEWATERED TAILINGS FILL PROPERTIES IN ONTARIO MINES

CANMET SCIENTIFIC AUTHORITY: ALFRED ANNOR

March 31, 1988 - Revised March 1990

Canada

Ontario

IN-SITU DETERMINATION OF DEWATERED TAILINGS FILL PROPERTIES IN ONTARIO MINES

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March 31, 1988 - Revised March 1990

257 pp

MICROMEDIA

Title: In-Situ Determination Of Dewatered Tailings Fill Properties In Ontario Mines.

Final Report
by: Denis Thibodeau
INCO Mines Research

Work on the project was conducted under the auspices of the Canada Centre for Mineral and Energy Technology, Energy, Mines and Resources Canada.

Dss File no.: 06SQ.23440-5-9240-I
Dss Contract Serial no.: OSQ85-00297
CANMET Project no.: 142502
CANMET Scientific Authority: Alfred Annor

Date: March 31, 1988

Revised March 1990.

APPENDICES

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Appendix B: Laboratory Results
Appendix C: In-Situ Monitoring Results and Calibration Curve
Appendix D: Fill Room Preparation and Pour Procedure
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Appendix G: Geological Description

Appendix A

In-Situ Sampling

Legend :

Deviator Stress = $\sigma_1 - \sigma_3$ in psi

Stress = σ_1 with a confinement pressure (σ_3) of 0 psi

Trow

PRELIMINARY REPORT

HIGH DENSITY BACKFILL CORE RECOVERY AND TESTING PROGRAM
LEVACK MINE
ONAPING, ONTARIO

PREPARED FOR:

INCO LIMITED

TROW ONTARIO LTD.
Toronto, Hamiltion, London
Sudbury, North Bay, Ottawa

Project: S01947R
February 15, 1988

1074 Webbwood Drive
Sudbury, Ontario P3C 3B7
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    3.4 Sample Retrieval .... Pg. 4
4.0 Laboratory Testing .... Pg. 8
5.0 Pressuremeter Testing .... Pg. 9
6.0 Discussions .... Pg. 9
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Test Results .... Fig. 1-7
Test Hole Summary .... Table 1

Trow

Rock Mechanics
and
Mining Division

Trow Ontario Ltd.
Consulting Engineers
1074 Webbwoo[illegible]e
Sudbury, Ontario. P3C 3B7
Telephone: (705) 674-9681

S01947R February 15, 1988

Inco Limited
Mines Research
38 Godfrey Drive
Copper Cliff, Ontario
POM 1NO

ATTENTION: Mr. J.L.D. Thibodeau
Research Engineer

Dear Sirs:

PRELIMINARY REPORT

HIGH DENSITY BACKFILL CORE RECOVERY AND TESTING PROGRAM
LEVACK MINE
ONAPING ONTARIO

Further to your authorization, we have completed field and laboratory work in connection with the above noted project. Our report and recommendations, based on the experience and results gained in the project, are summarized in the following paragraphs.

1.0 INTRODUCTION

Inco Limited representatives approached Trow on December 17, 1987, and requested that we undertake an experimental drilling program on the 900 level of Levack Mine. The test drilling was to be performed on the high density backfill containing nominal 5/8" stone mixed in with tailings material. It is our understanding that the pour was placed at over 80% pulp density and was a 20:1 mix using normal Portland type 10 cement as the binder

On January 8th, 1988, we visited the Levack Mine to examine the particular drift in question. The drift had been mined to about a 9.0 foot height and subsequently filled with the high density material. The drift was then undercut exposing the backfill overhead. A plan of the drift is shown on Dwg. 1, enclosed.

The above mining activity took place in 1986-1987 and in the interlude the drift has been used as a waste storage area making access and working conditions difficult. This point is particularly relevant with respect to setting up larger, more advanced diamond drilling equipment. The head room in the drift was restrictive as was the footing conditions.

2.0 TERMS OF REFERENCE

The outcome from the above mentioned meetings was to establish the terms of reference given below.

1) Trow will attempt to recover 6 inch diameter core for compressive strength tests. Drill locations will be set out by Inco so as to not damage the monitoring equipment placed into the fill (i.e., see Dwg. 1 for test locations).

2) Trow will drill 3 inch diameter boreholes to attempt pressuremeter tests. Trow will use their Texam pressuremeter and the Probex 1 dilatometer, if possible, as agreed to with CANMET.

3) Trow will conduct laboratory tests on any recovered samples; specifically, uniaxial compressive strength with elastic parameter determination. Block samples would be recovered by Inco pending drill results.

4) Trow would supply an electric coring machine, special double density coring bits and all necessary equipment to undertake the drill work. Note, Trow did contact diamond drilling subcontractors with suitable split inner tube core barrel equipment and found that the project budget was not sufficient for subcontracting.

It was agreed that, should the project warrant the added expense (i.e., the lighter electric drill failed to achieve any results), the drift might be cleaned out and a BBU2 type of drill, with 6 and 3 inch inner tube coring equipment, could be brought in.

5) The time frame for completing the above mentioned coring program was January 31, 1988.

3.0 FIELD WORK

Field work was started January 16th, at which time the drilling equipment was sent underground, and completed January 29th, when the equipment was brought up from underground.

Test holes were drilled at the locations shown on Dwg. 1. Retrieved core was carefully wrapped and brought back to our laboratory in Sudbury. A summary of the testhole results is given in Table 1 enclosed.

3.1 Drilling Equipment

The coring was undertaken with an industrial electric diamond drill. The rod rotation found to have the best results was 900 rpm (i.e., high speed). The core barrels were 3 inch and 6 inch diameters respectively with length of 18 inches. Water was used for borehole advancement and removal of backfill cuttings.

3.2 Drilling Arrangement

Access and transportation, from surface to the entrance of the test drift presented no major problems. However, the test drift area was cluttered and in some areas quite rugged.

The floor area was irregular and timber staging had to be constructed prior to drilling as shown in photographs 1 and 2. The drill was bolted to the staging and covered with a tarp to protect the unit from water.

A typical close-up of the actual drilling operations is shown in photograph 3.

Installation of a 120 V, 20 amp. electric service line was supplied by Inco. Water for drilling was readily available at the entrance of the drift.

3.3 Water Pressures, Feedrates, RPM Data

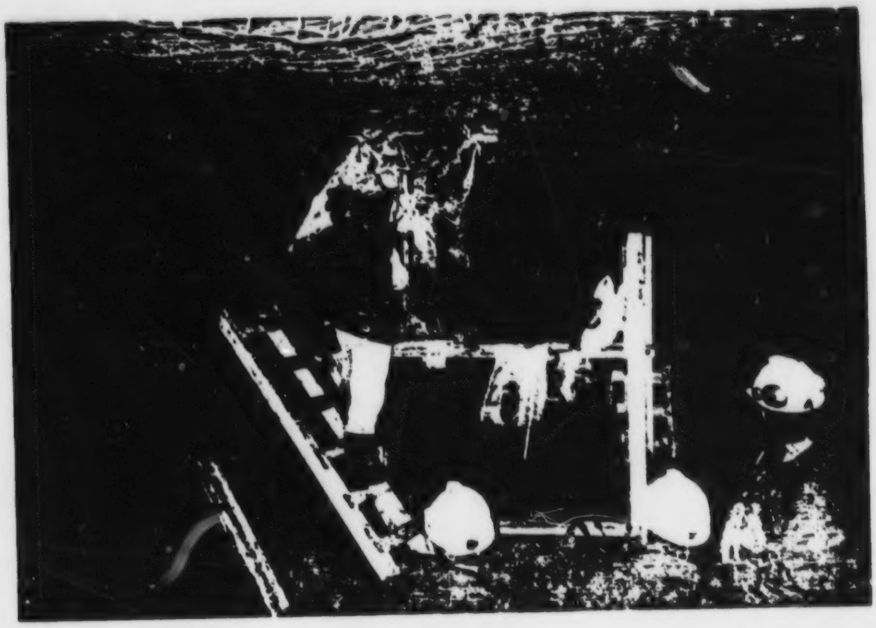
During the core recovery in testhole 1, optimum values for water pressure, drill feedrates and rpm were established. The feedrate was maintained between 0.79 to 1.18 inches/min. with a rotation of 900 rpm. A constant water pressure of 125 psi was maintained.

3.4 Sample Retrieval and Borehole Condition

Sample recovery using the 6 inch diameter thin wall bit was reasonably successful for this type of backfill material. Our main goal was to obtain an intact sample, with minimal disturbance associated with it, to use in an unconfined compressive strength test..

Stones in the backfill (i.e., set in the weakly cemented matrix) resulted in damage to both core samples and to the sidewalls of the borehole. A lathed action resulted in some samples, and boreholes were generally enlarged by the action of stones against the bit and backfill.

Difficulty was encountered in trying to retrieve samples from the core barrel without disturbance, but recovery could be achieved with care. Photograph 3 shows a close-up of the 6 inch thin wall samples attached to the drill unit. Core recovery was 83% and was virtually undistrubed for the first run.



PHOTOGRAPH #1

Staging with drill set-up

PHOTOGRAPH #2

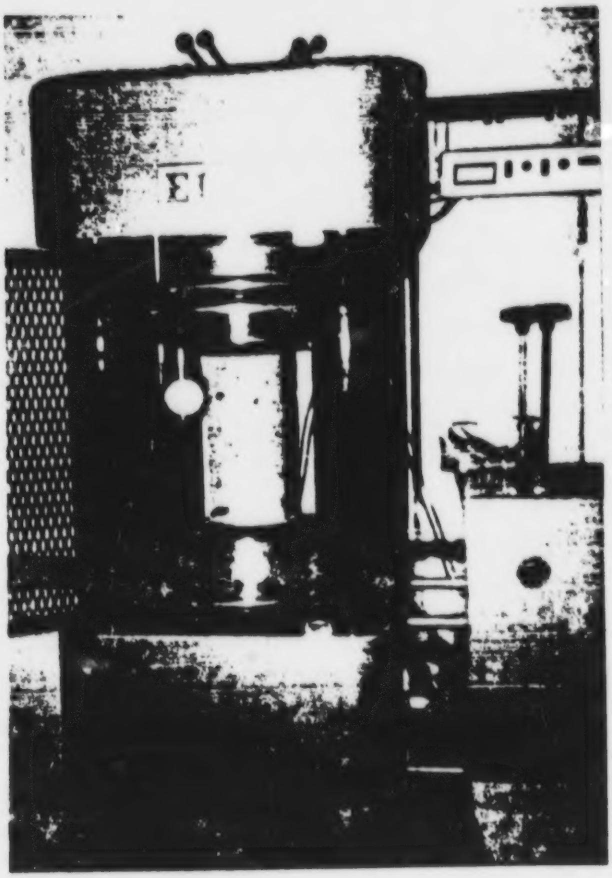
Staging with drill setup

PHOTOGRAPH #3

Close-up of core drill
drilling 6 inch diameter hole

PHOTOGRAPH #4

Core recovered from
6 inch thin wall core barrel



PHOTOGRAPH #5

Set-up for a Uniaxial Compressive Test

PHOTOGRAPH #6

Type of failure on high density backfill core under unconfined loading.

The primary purpose for the 3 inch diameter testholes was to undertake pressuremeter testing. It was also our hope to obtain cores for additional laboratory testing (i.e., possible uniaxial and triaxial work).

General observations indicate that coring 3 inch diameter samples is less effective than coring 6 inch diameter samples. However, two good samples were retrieved and saved for uniaxial compressive strength tests. The majority of the samples retrieved with the 3 inch samples were badly broken and sheared.

4.0 LABORATORY TESTING

Compressive strength tests were performed on one 6 inch and two 3 inch samples with the corresponding axial deformation recorded. Results of these tests have been summarized on the enclosed compressive strength / % strain graphs (Figure 1 to 3).

Based on the result of the one 6 inch sample (tested under carefully controlled conditions), the Levack high density backfill has a compressive strength of 435 psi. This single test data fits well with the compressive strength vs. deformation modulus relationship prepared by G. Swan (1985) shown in Fig. 4. The result is also in good agreement with previous Trow laboratory tests performed on specimens cast by Inco.

The two 3 inch specimens (which were both somewhat coarse) had compressive strength results of between 220 - 240 psi. These lower strength values are considered to be a result of coring difficulties, and reflect the quality of the cores not the backfill.

5.0 PRESSUREMETER TESTING

Texam pressuremeter tests, inside the 3 inch diameter boreholes, were not successful due to the overall enlargement of the boreholes by stones. A 2½ inch bit was also advanced into the backfill, but even use of different sized pressuremeter membranes failed to produce good results. The limited results that were achieved are shown in Figures 5 to 7, inclusive.

It was found that up to 60% of the available volume in the pressuremeter was used to make membrane contact with the borehole wall. This confirms that the boreholes were too large. The limit pressure of the backfill could not be obtained because of the lack of additional membrane expansion. The relative stiffness of the backfill was consequently under estimated. The preliminary data reduction indicates the values for deformation modulus, E_m (Menard Modulus) are as follows:

TEST #	E_m
1	3626 psi (25.0 MPa)
2	2466 psi (17.0 MPa)
3	1146 psi (7.9 MPa)

6.0 DISCUSSIONS

Based on the results and findings in the field, some refinements must be made with regards to drilling and sampling techniques. The following problems and comments are given for future consideration.

1) Extruding core samples from the thin wall sampler presented problems. To avoid this problem, a modified thin wall "split barrel" coring sampler or alternatively a double tube core barrel system should be used for this type of work. The concept of modifying a standard coring bit to a "split barrel" coring bit (sampler) seems to be a more practical solution for the electric coring drill arrangement.

2) Water entering the housing unit of the electric drill created problems. In the future, the electric drill should be modified with a waterproof seal and a water deflector.

3) Drilling and sampling was conducted in a very difficult area because of the waste placed in the drift. This restricted movement and so on. The lightweight electric drill offers more control and flexibility for this type of work, and was preferred by the operators who conducted similar work with air drills at Dome Mines.

4) Pressuremeter results are not useful under the circumstances. It is believed that smooth borehole walls are unlikely to occur because of the problem with stones in the backfill.

5) Laboratory testing of retrieved core samples produced acceptable results. The results agree with earlier laboratory test results performed by Trow, for the same material, under Inco contract. Block samples have been secured from the experimental drift and 3 inch core samples will be drilled from these block samples.

7.0 RECOMMENDATIONS

No additional underground drilling is recommended in the backfill unless the drift is mucked out.

Block samples have been retreived from the test area by Inco and have been brought to the Rock Mechanics Lab. Uniaxial and triaxial test results should be forthcoming from the samples.

We trust the above information is satisfactory and should you have any questions, please do not hesitate to contact this office.

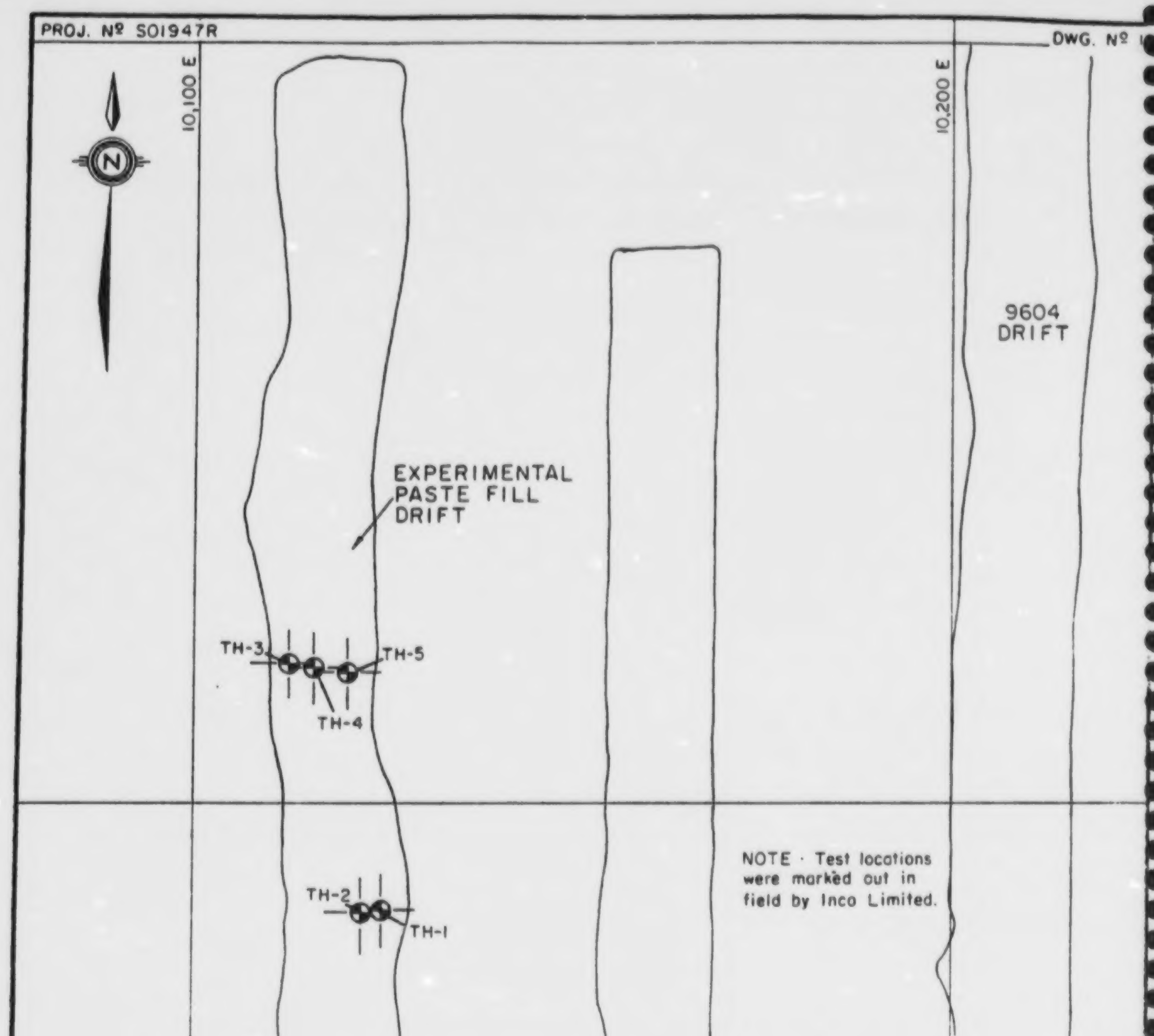
Yours very truly,
TROW ONTARIO LTD.

Greg Hunt

W.G. Hunt, P.Eng.
Rock Mechanics & Mining Division

REGISTERED PROFESSIONAL ENGINEER
W. G. HUNT
PROVINCE OF ONTARIO

WGH:jak



PROJ. Nº S01947R
DWG. Nº
N
10,100 E
10,200 E
9604 DRIFT
EXPERIMENTAL PASTE FILL DRIFT
TH-3
TH-4
TH-5
TH-2
TH-1

NOTE · Test locations were marked out in field by Inco Limited.

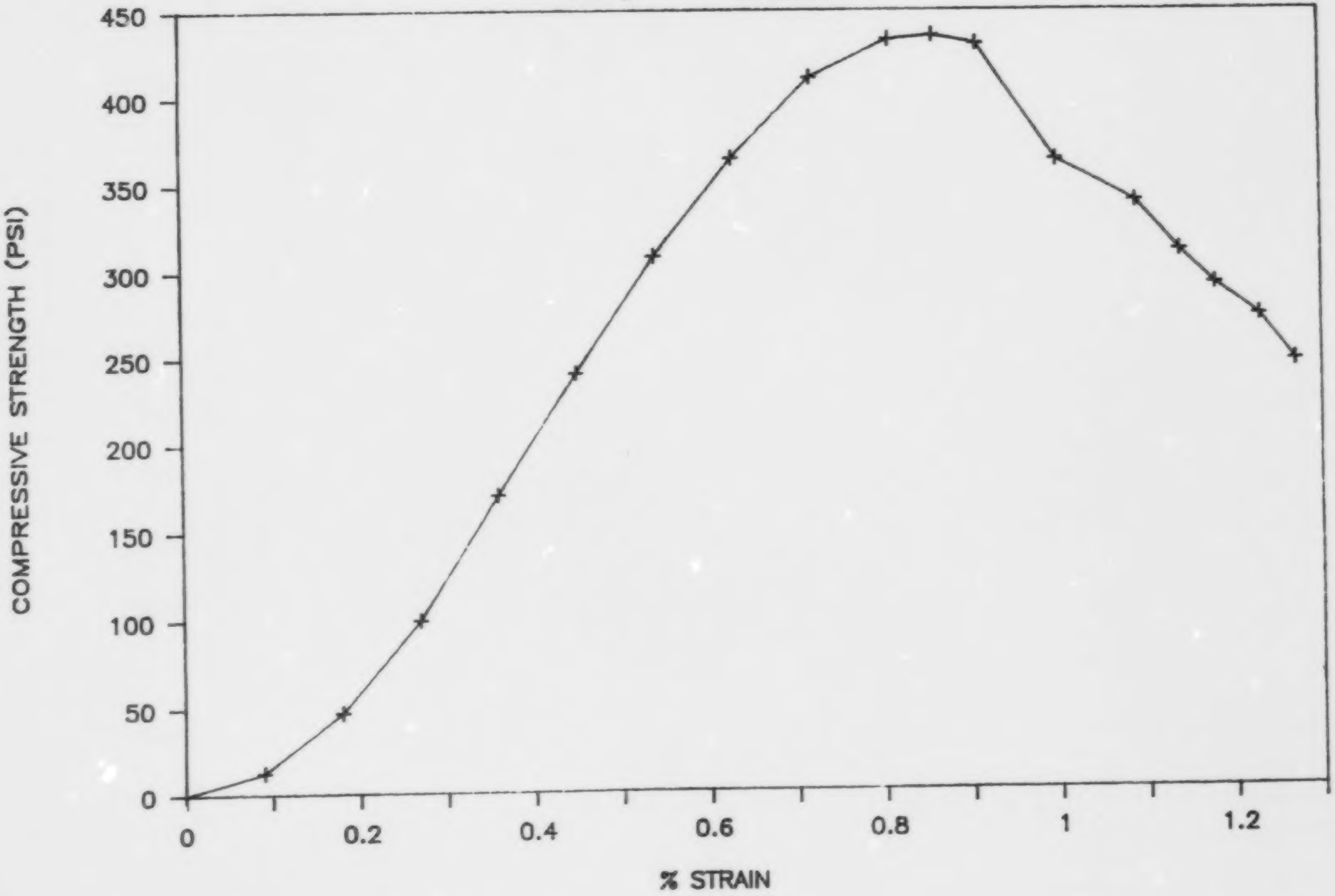
INCO LEVACK MINE
900 LEVEL
SCALE 1" = 20'

DRAWN - FEBRUARY 1988

TROW ONTARIO LIMITED

S01947R

Fig. 1



LEVACK HIGH DENSITY BACKFILL

TEST #1 – 6" DIAMETER

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Fig. 2

LEVACK HIGH DENSITY BACKFILL

TEST #2 – 3" DIAMETER

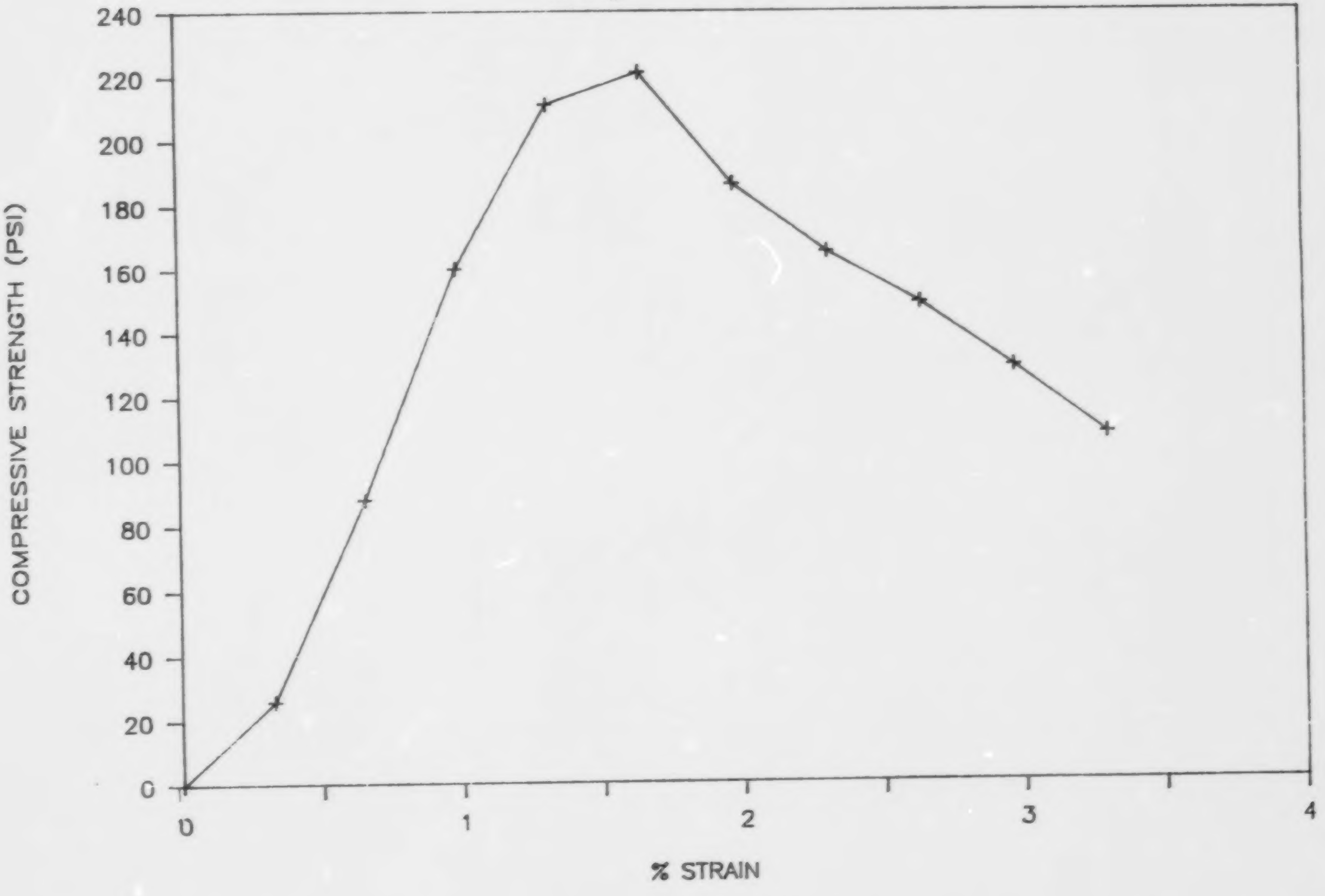

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Fig. 3

LEVACK HIGH DENSITY BACKFILL

TEST #3 – 3" DIAMETER

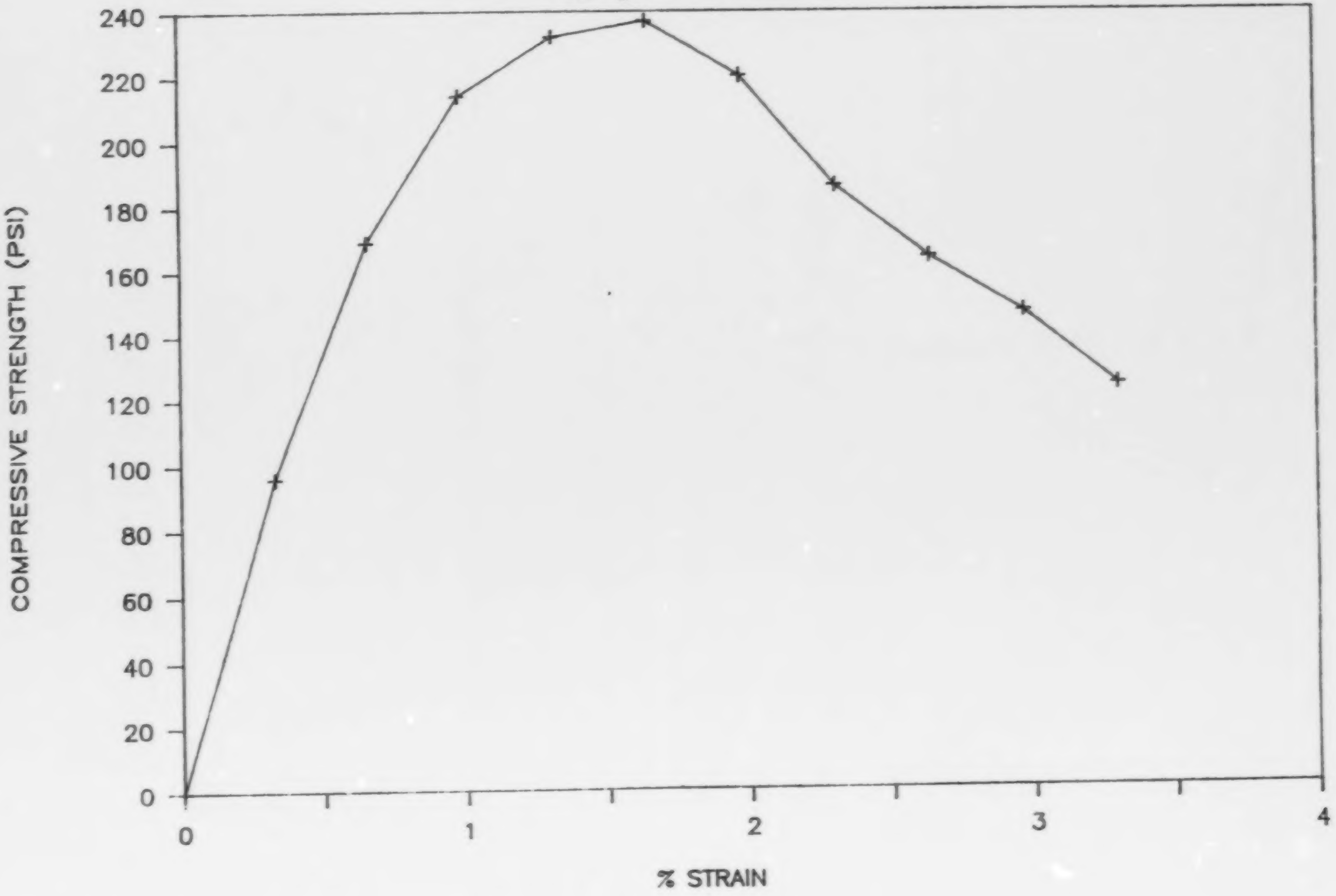

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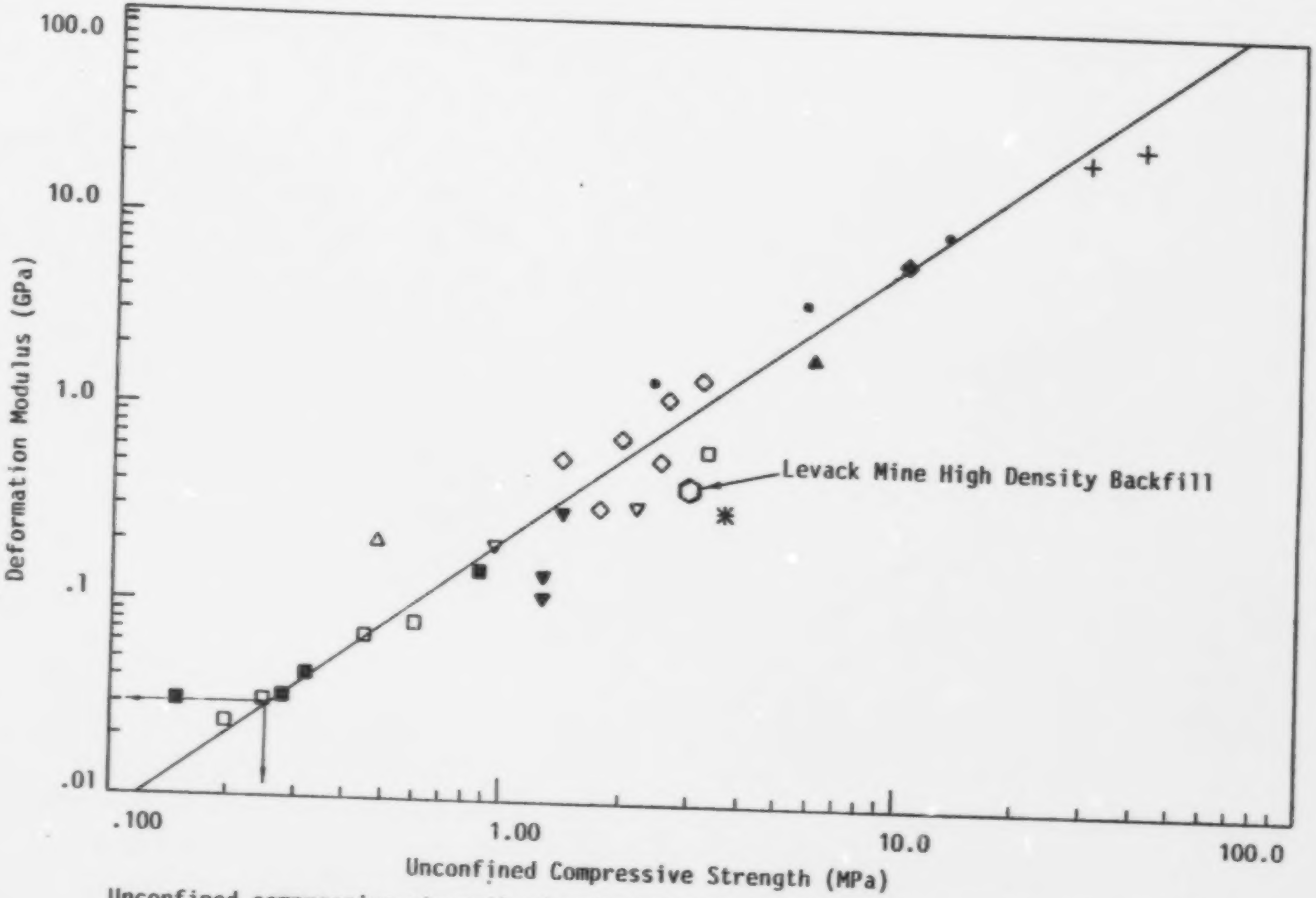
Fig. 4



Unconfined compressive strength of selected mine backfills and concretes versus deformation modulus. (Swan 1985)

S01947R

Fig. 5

LEVACK HIGH DENSITY BACKFILL

TEST #1

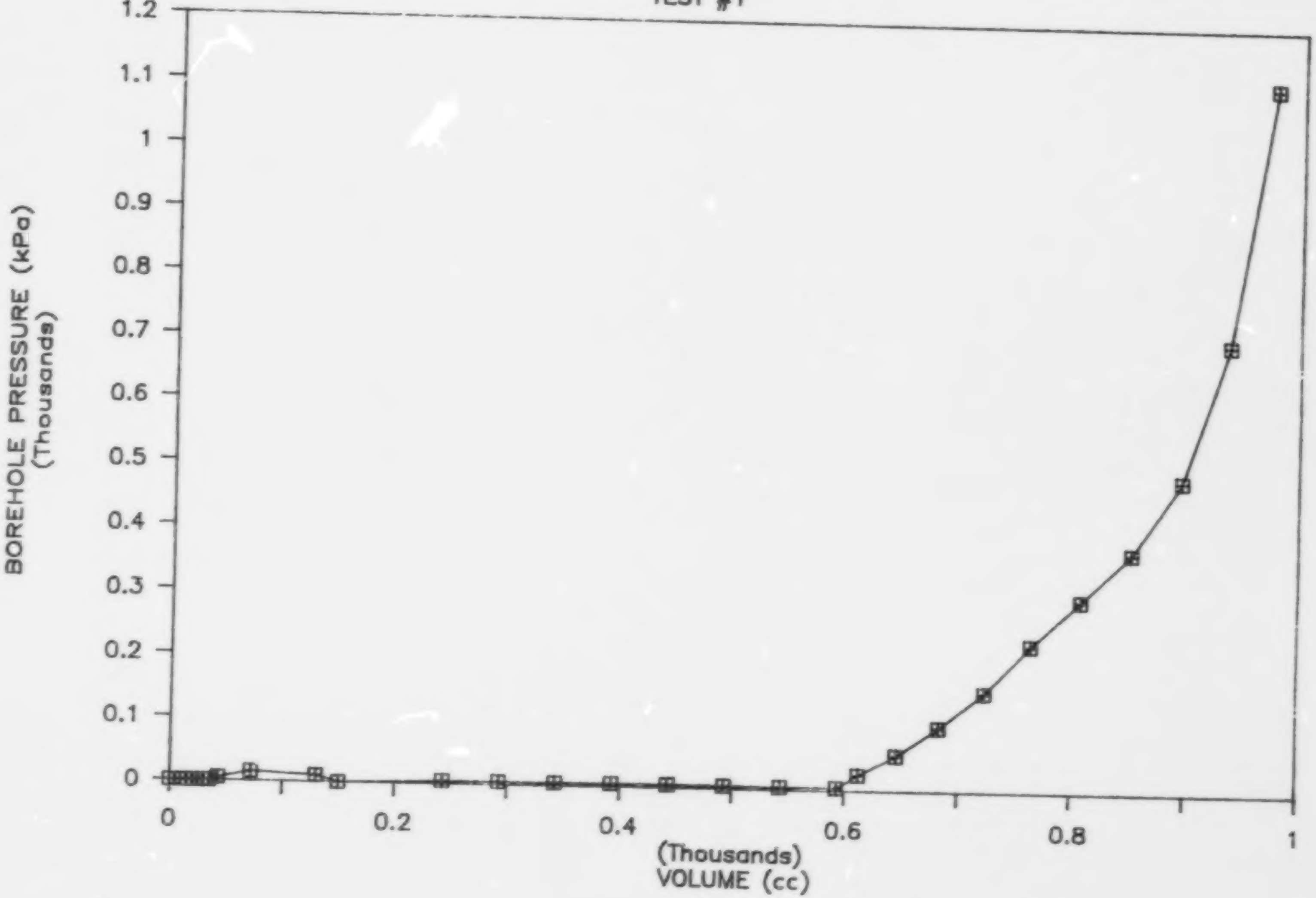


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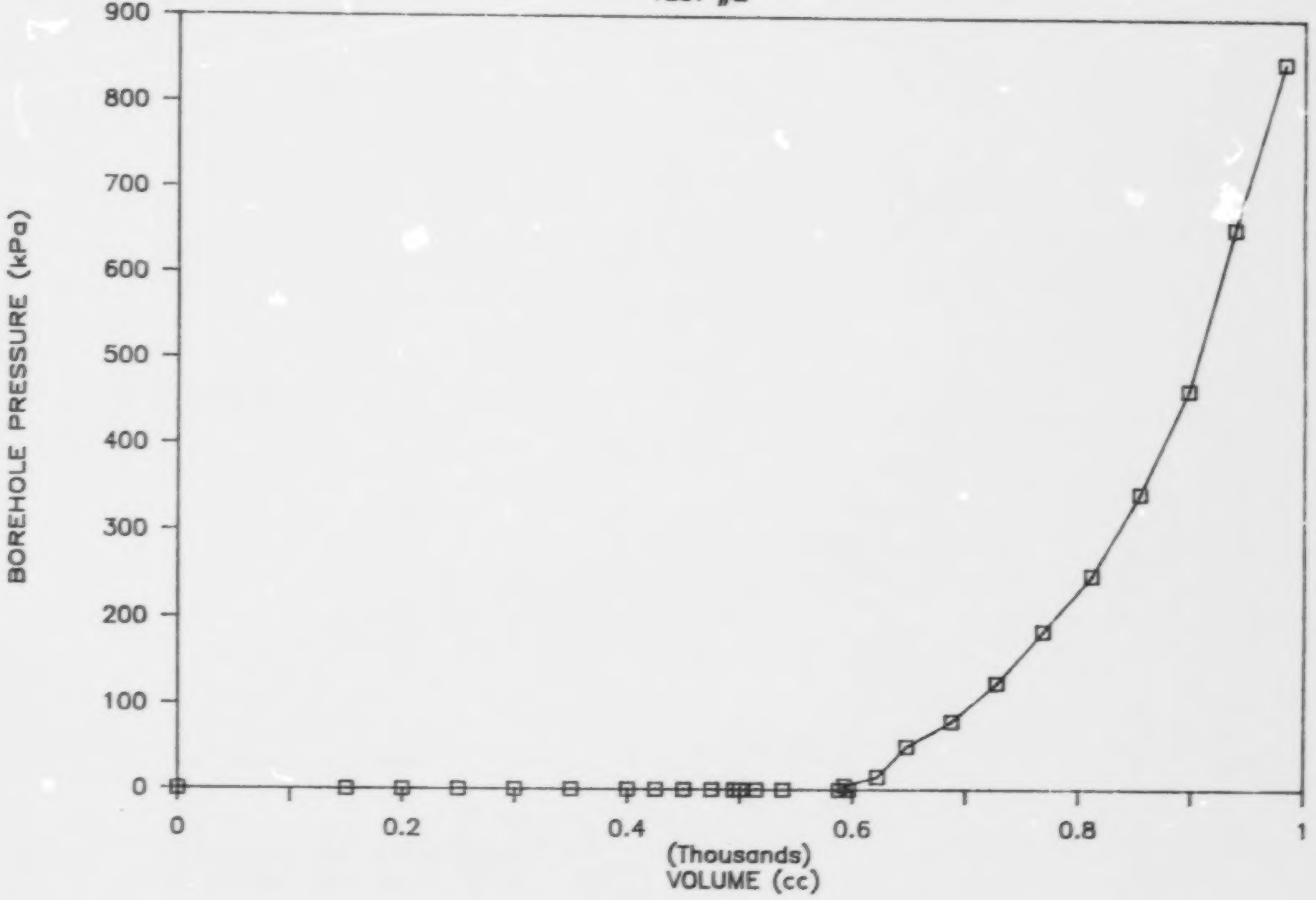
Fig. 6

LEVACK HIGH DENSITY BACKFILL

TEST #2

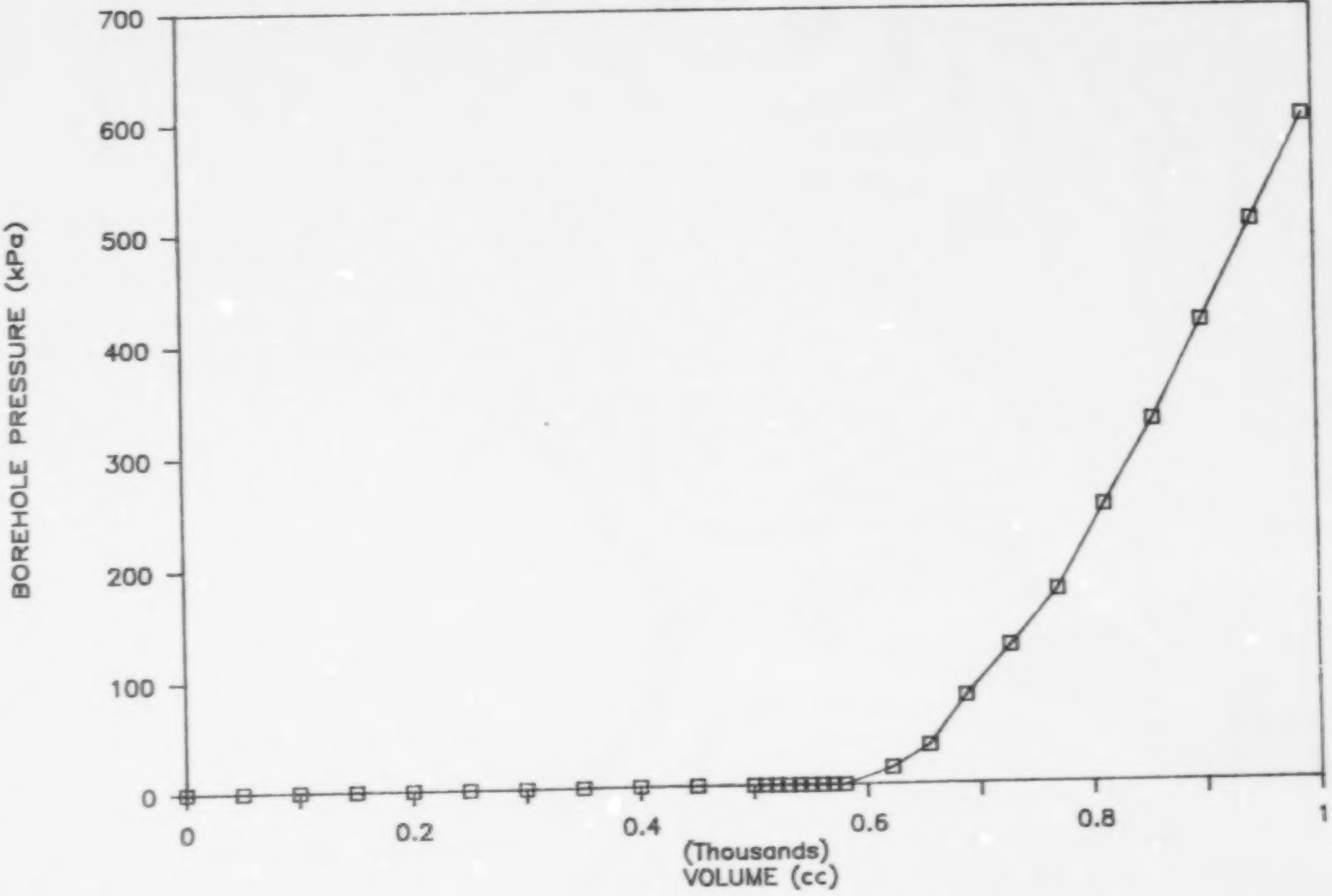


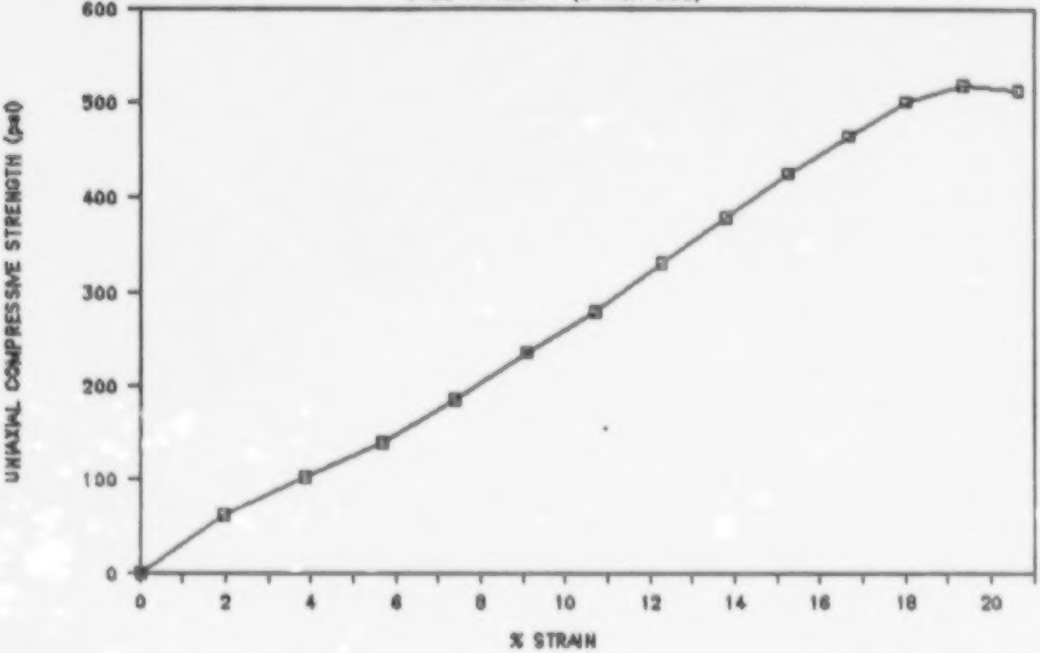
S01947R

Fig. 7

LEVACK HIGH DENSITY BACKFILL

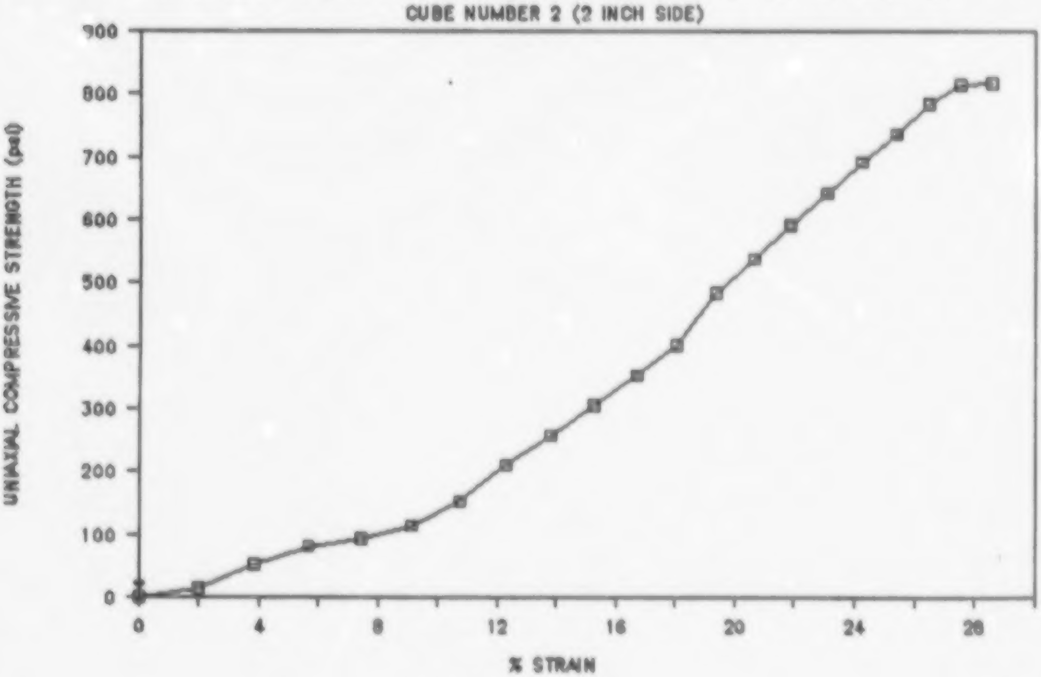
TEST #3





LEVACK HIGH DENSITY FILL IN-SITU SAMPLE

CUBE NUMBER 1 (2 INCH SIDE)

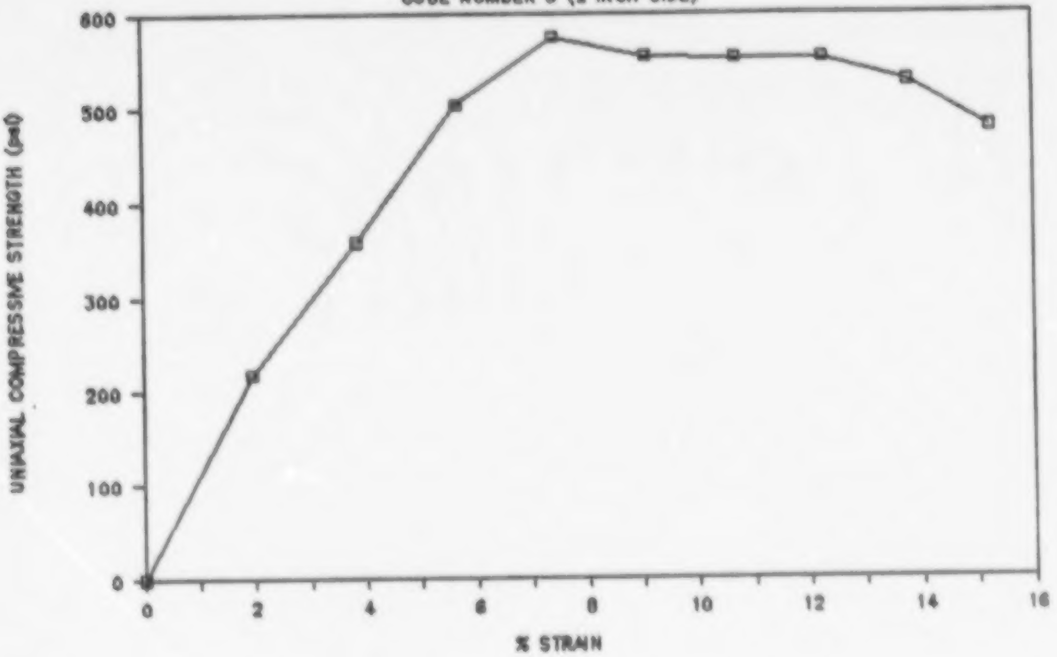


LEVACK HIGH DENSITY FILL IN-SITU SAMPLE

CUBE NUMBER 2 (2 INCH SIDE)

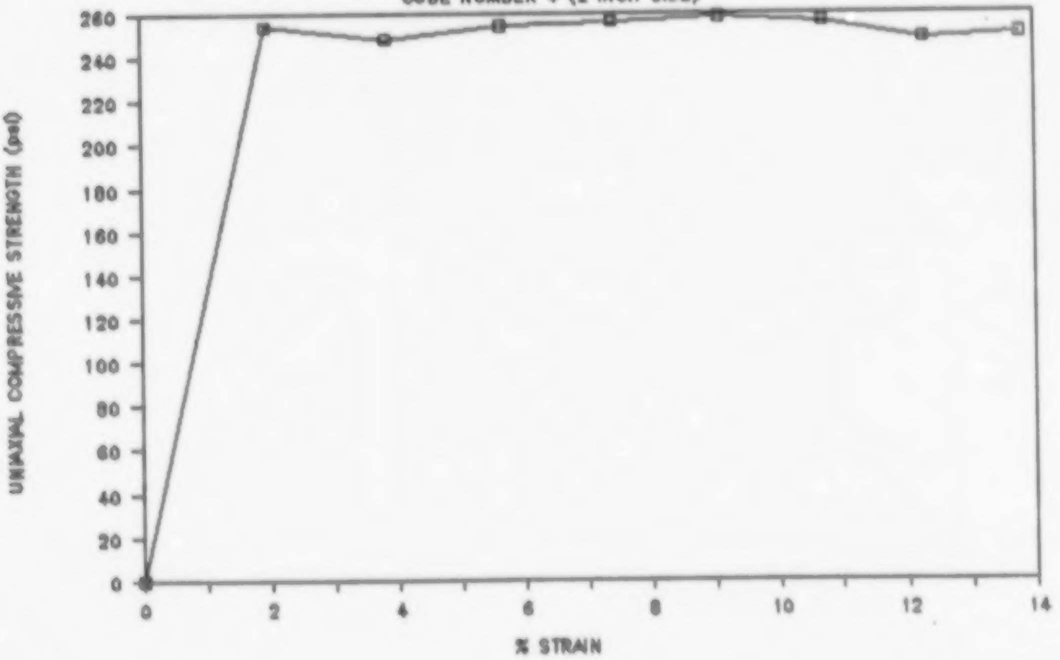
LEVACK HIGH DENSITY FILL IN-SITU SAMPLE

CUBE NUMBER 3 (2 INCH SIDE)



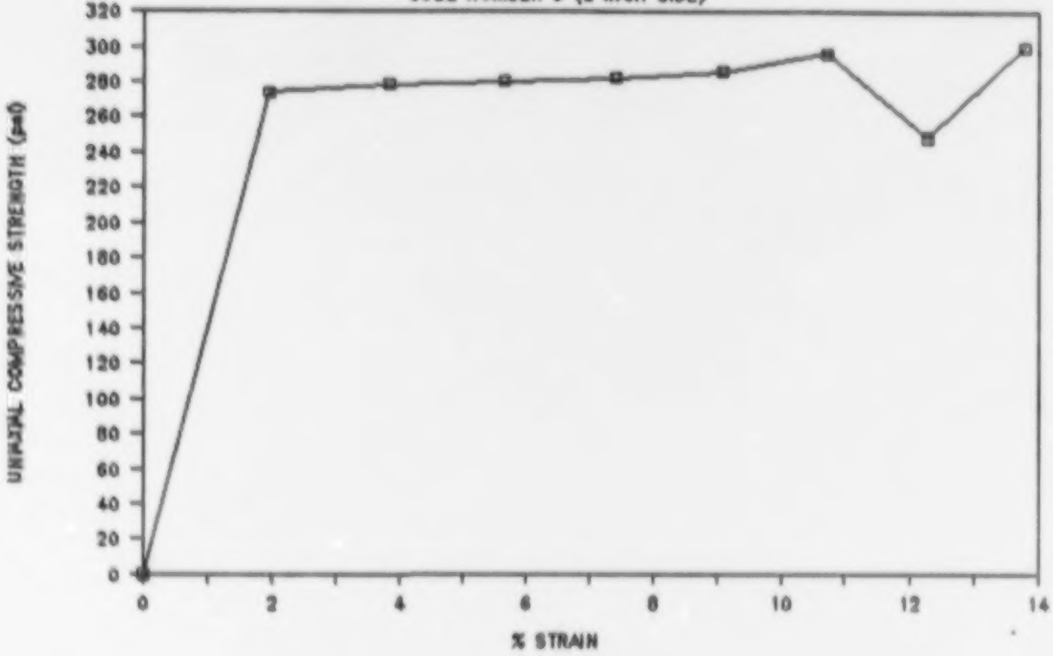
LEVACK HIGH DENSITY FILL IN-SITU SAMPLE

CUBE NUMBER 4 (2 INCH SIDE)



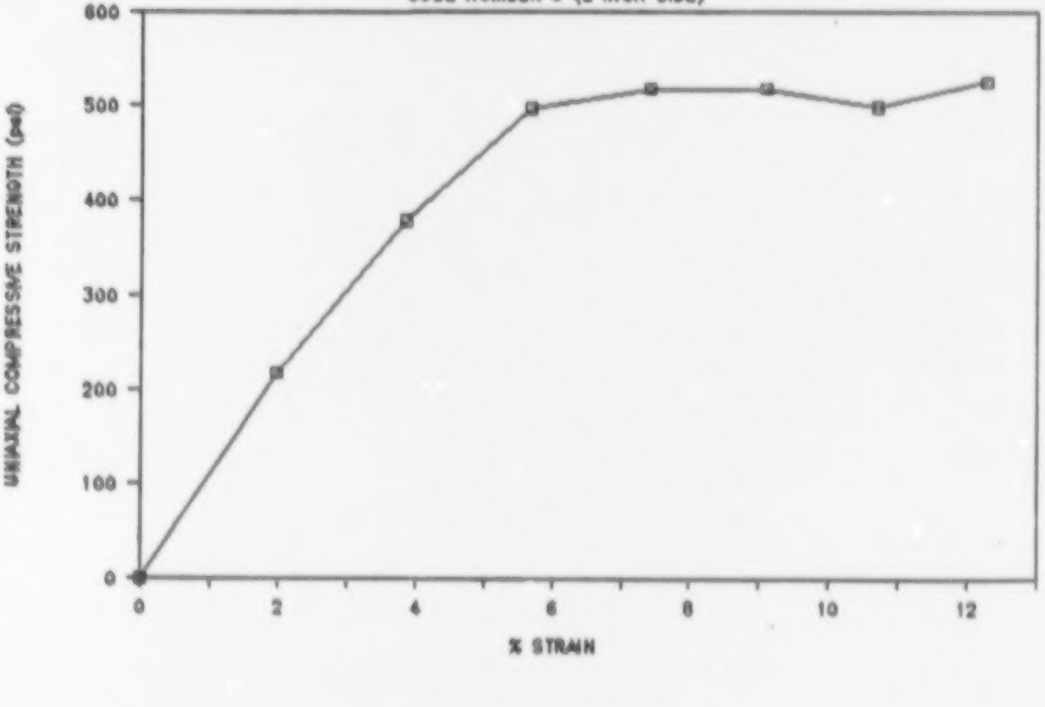
LEVACK HIGH DENSITY FILL IN-SITU SAMPLE

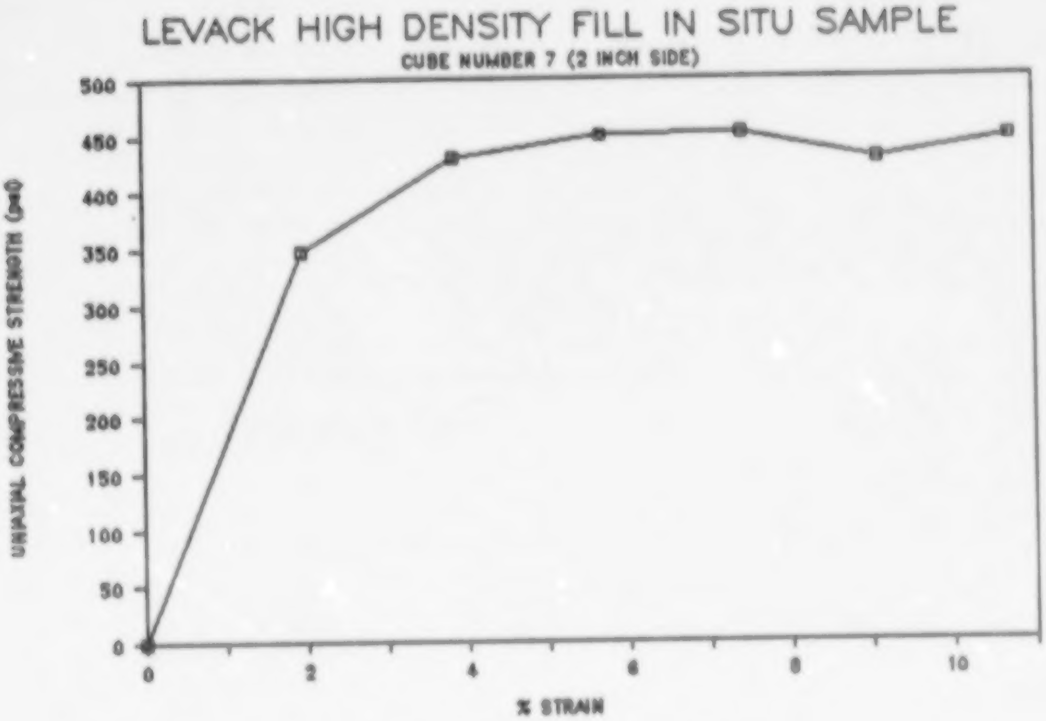
CUBE NUMBER 5 (2 INCH SIDE)



LEVACK HIGH DENSITY FILL IN-SITU SAMPLE

CUBE NUMBER 6 (2 INCH SIDE)





LEVACK HIGH DENSITY FILL IN SITU SAMPLE

CUBE NUMBER 7 (2 INCH SIDE)

TESTHOLE SUMMARY
TABLE 1

TESTHOLE NO.	DIAMETER (in.)	LENGTH (ft.)	COMMENTS
1	3	9.0	- stratified core (badly broken) - as drilling increased with depth core recovery decreased - fairly easy penetration
2	6	1.5	- excellent core recovery - 15 inches recovered
3	6	1.8	- two runs attempted - both runs the core broke into 2 parts - specimens can be trimmed down to 4 inch size for testing
4	6	1.3	- no core recovery - large aggregates present - minimal cement content
5	3	7.0	- stratified - soft spot encountered between 5 and 6 feet - large stones 2 3/4 inch core barrel

Trow

**Rock Mechanics
and
Mining Division**

Trow Ontario Ltd.
Consulting Engineers
1074 Webbwood Drive
Sudbury, Ontario. P3C 3B7
Telephone: (705) 674-9681

S01947R

March 23, 1988

Inco Limited
Mines Research
38 Godfrey Drive
Copper Cliff Hospital
Copper Cliff, Ontario
POM 1NO

**ATTENTION: Mr. J. L. D. Thibodeau
Research Engineer**

Dear Sirs:

**HIGH DENSITY BACKFILL CORE RECOVERY
AND TESTING PROGRAM
LEVACK MINE
ONAPING, ONTARIO**

Subsequent to our last report (S01947R) Trow Ontario Ltd. was asked to extend the study of the Levack mine backfill and determine the physical characteristics of this material. These included the grain size distribution, moisture content, void ratio and bulk relative density. This data has been summarized in Table 1 and in Figures 1 and 2.

TABLE 1

	Cube 1	Cube 2
Cu	2.0	2.15
Cc	.90	1.19
Moisture content	8.1%	8.2%
Bulk relative density	2129 kg/m^3	2103 kg/m^3
Void ratio	.315	.331

I trust you will find this data to your satisfaction.

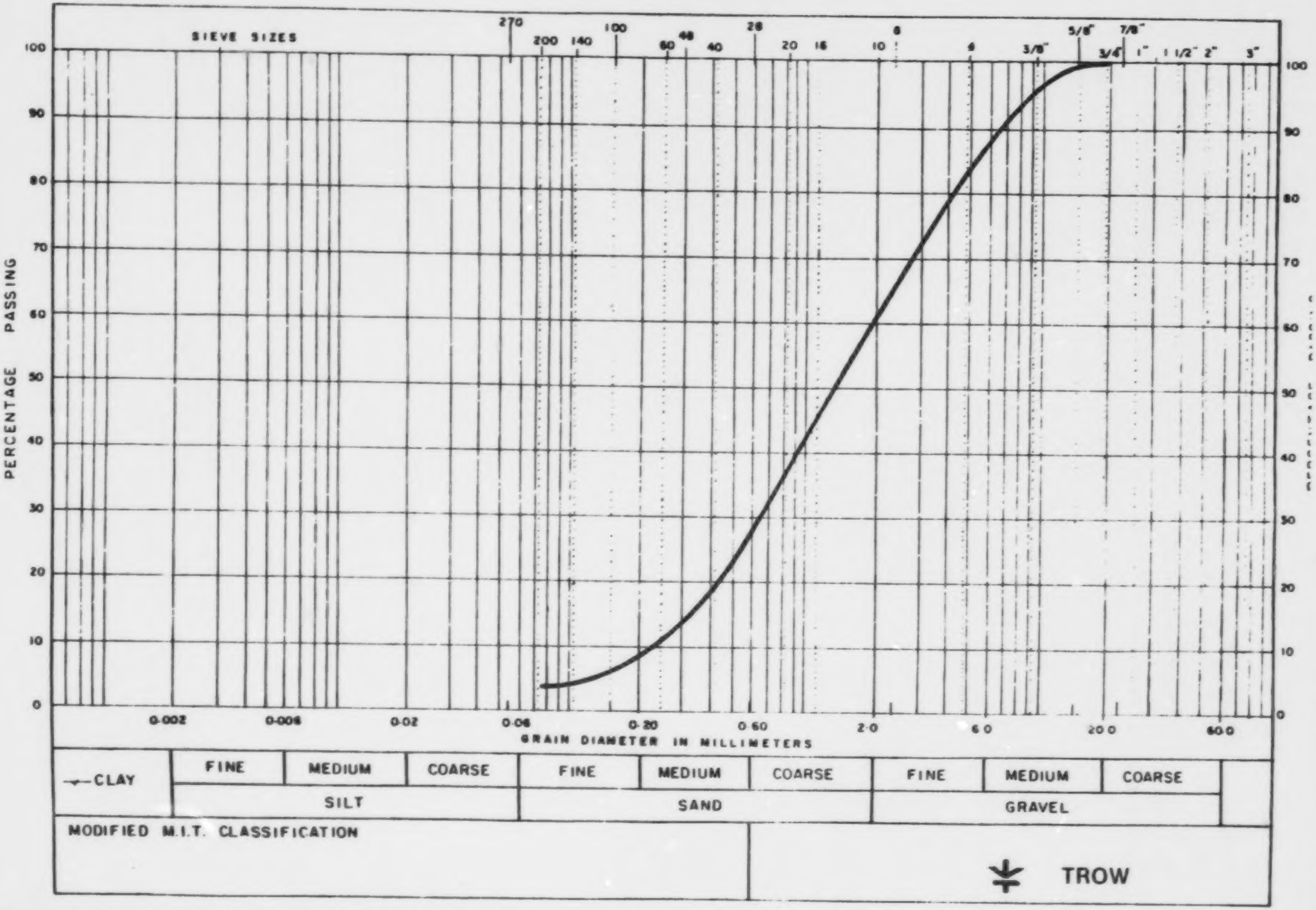
Cu: Coefficient of Uniformity
Cc: Coefficient of Curvature

Yours very truly,
TROW ONTARIO LTD.

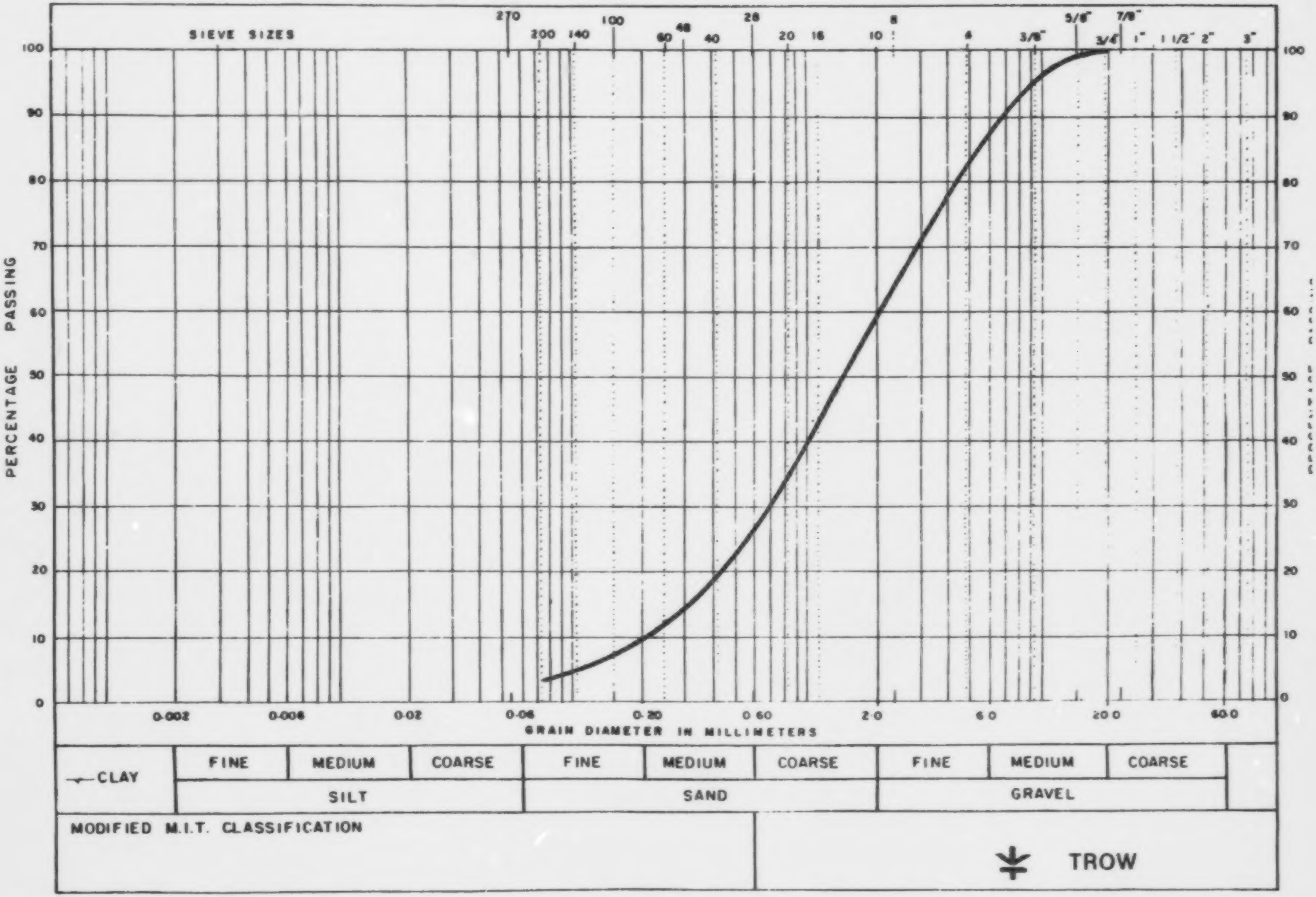
Luciano Piciacchia, Ph.D.
Sr. Rock Mechanics Eng.

LP:lstp

MECHANICAL ANALYSIS



MECHANICAL ANALYSIS



Appendix B

Laboratory Results

Trow Sudbury Branch

Trow Ontario Ltd.
Consulting Engineers
1074 Webbwood Drive
Sudbury, Ontario. P3C 3B7
Telephone: (705) 674-9681

S861345M

January 16, 1987

Inco Limited
Mines Research
Copper Cliff Hospital
Copper Cliff, Ontario
POM 1NO

ATTENTION: Mr. B. Goard

Dear Sirs:

LABORATORY TESTING
MINE FILL SAMPLES
YOUR P.O. 05945

As per your request, we are in receipt of the first series of mine fill samples for triaxial and uniaxial testing.

Samples are numbered and detailed as follows:

Trow No.	Inco No.	Diameter (inches)	Date Cast	Age Tested (days)	Comments
L-1A	A	2	Nov.10/86	30	triaxial - drained
L-1B	A	2	Nov.10/86	29	triaxial - drained
L-2	B	2	Nov.10/86	28	triaxial
L-3A	C	2	Nov.10/86	28	triaxial
L-3B	C	2	Nov.10/86	31	triaxial - drained
L-4	D	6	Nov.10/86	--	excess voids - no test
L-5	E	6	Nov.10/86	--	excess voids - no test
L-6	F	6	Nov.10/86	28	uniaxial
L-7	G	6	Nov.10/86	28	uniaxial
L-8A	I	2	Nov.19/86	28	triaxial
L-8B	I	2	Nov.19/86	28	triaxial
L-9A	2	2	Nov.19/86	28	triaxial
L-10	3	2	Nov.19/86	7	triaxial
L-11*	4	2	Nov.19/86	168	triaxial
L-12A	5	2	Nov.19/86	7	triaxial

Trow No.	Inco No.	Diameter (inches)	Date Cast	Age Tested (days)	Comments
L12-B	5	2	Nov.19/86	7	triaxial
*L-13	6	2	Nov.19/86	168	triaxial
L-14	7	2	Nov.19/86	--	spare
L-15	8	2	Nov.19/86	--	spare
L-16	9	2	Nov.19/86	--	spare
L-17	10	2	Nov.19/86	6	triaxial
L-18	11	2	Nov.19/86	--	spare
L-19	12	2	Nov.19/86	--	spare
L-20	1	6	Nov.19/86	7	uniaxial
L-21	2	6	Nov.19/86	7	uniaxial
L-22	4	6	Nov.19/86	7	uniaxial
L-23	5	6	Nov.19/86	7	uniaxial
L-24	7	6	Nov.19/86	7	uniaxial
L-25	8	6	Nov.19/86	7	uniaxial
L-26	3	6	Nov.19/86	28	uniaxial - samples damaged
L-27	6	6	Nov.19/86	28	uniaxial - samples damaged
L-28	9	6	Nov.19/86	28	uniaxial - samples damaged

Denotes tests not included in this report, as they are in progress or have yet to be performed.

As per your instruction, all samples were stored in a moist curing room within a temperature range of 20°C to 25°C at a relative humidity of 100%.

All samples for uniaxial and triaxial tests were loaded at a strain rate of 0.08 inches/minute. Moisture contents and wet and dry unit weights were recorded for each sample.

All data is summarized on the enclosed stress/strain curves.

As discussed, diametric movements of the 6 inch cylinders could not be accurately measured with normal dial gauging apparatus (i.e., readings were erratic and inconsistent). For this reason, we have not included stress/strain curves for this portion of the work, with the exception of sample L-20. You will note that the lateral strain measurements for this sample (included strictly as a typical example) cannot be considered to be meaningful.

This problem is thought to be the result of the non-homogeneous nature of the samples, as well as possible lateral movements of the equipment during loadings. To overcome this problem, we have ordered a compressometer-extensometer which can provide more accurate measurement of overall diametric movements. It is hoped that the compressometer-extensometer will be delivered within the next two weeks.

All stress/strain curves for axial loadings are plotted directly, with no corrections for volumetric displacement.

Should you have any queries, please do not hesitate to contact our office.

Yours very truly,
TROW ONTARIO LTD.

Dennis A. Pigeau
Materials Manager

K. J. Jansons, P.Eng.

DAP:gmv
Encl.

REVISED

TABLE 1

INCO NO.	DIAMETER (inches)	DATE CAST	AGE TESTED (days)	COMMENTS
4A	2	Nov. 19	168	Triaxial Undrained
6A	2	Nov. 19	168	" "
6B	2	Nov. 19	168	" "
2	6	Feb. 24	7	Uniaxial
6	6	Feb. 24	7	"
10	6	Feb. 24	7	"
4	6	Feb. 24	28	"
8	6	Feb. 24	28	"
12	6	Feb. 24	28	"
5A	6	Feb. 24	28	Triaxial Undrained
5B	6	Feb. 24	28	" "
7A	6	Feb. 24	28	" "
9 *	6	Feb. 24	168	" "
11 *	6	Feb. 24	168	" "
1	2	Feb. 24	7	Sample Damaged
3	2	Feb. 24	7	" "
13	6	Mar. 2	7	Uniaxial
15	6	Mar. 2	7	"
14	2	Mar. 2	7	Triaxial Undrained
16	2	Mar. 2	7	" "
16A	6	Mar. 2	7	" "
17	6	Mar. 2	7	Uniaxial
19	6	Mar. 2	7	"
21	6	Mar. 2	28	"
23	2	Mar. 2	28	"
18	2	Mar. 2	7	Triaxial Undrained
20	2	Mar. 2	7	Triaxial Undrained
20A	2	Mar. 2	7	" "
22A	2	Mar. 2	28	" "
22B	2	Mar. 2	28	" "
24A	2	Mar. 2	28	" "

TABLE 1
(cont'd)

INCO NO.	DIAMETER (inches)	DATE CAST	AGE TESTED (days)	COMMENTS
1	6	Mar. 3	7	Uniaxial
3	6	Mar. 3	7	"
4A	2	Mar. 4	28	Triaxial Undrained
4B	2	Mar. 4	28	" "
2A	2	Mar. 4	28	" "
5	6	Apr. 8	7	Uniaxial
7	6	Apr. 8	7	"
9	6	Apr. 8	7	"
13	6	Apr. 8	7	"
4	6	Apr. 8	28	"
11	6	Apr. 8	28	"
6	2	Apr. 8	7	Triaxial Undrained
8	2	Apr. 8	7	" "
8A	2	Apr. 8	7	" "
10	2	Apr. 8	28	" "
10A	2	Apr. 8	28	" "
12	2	Apr. 8	28	" "
2	6	Apr. 9	7	Uniaxial
1	6	Apr. 9	28	"

* Denotes still in progress.

TABLE 2

Inco Number	Wet Unit Weight (p.c.f.)	Moisture Content (%)	Dry Unit Weight (p.c.f.)
4A	138.2	13.9	121.3
6A	140.0	14.3	122.4
6B	138.0	14.2	120.8
2	141.4	11.7	126.5
6	137.2	13.1	121.3
10	134.8	14.5	117.7
4	136.9	12.2	122.0
8	136.5	12.6	121.2
12	134.1	14.5	117.1
5A	137.6	15.5	119.0
5B	136.8	15.8	118.1
7A	137.6	14.1	120.4
13	135.6	12.3	120.7
15	133.3	17.2	113.7
14	131.6	12.6	116.8
16	137.1	8.1	126.8
16A	134.8	10.6	121.9
17	134.4	17.2	114.7
19	133.6	12.9	118.3
21	140.0	8.1	129.5
23	138.5	7.3	129.0
18	131.4	14.1	115.1
20	133.0	9.9	121.0
20A	131.2	11.6	117.6
22A	144.2	13.9	126.6
22B	139.8	13.1	123.6
24A	144.4	11.8	129.2
1	133.9	16.4	115.0
3	134.6	16.2	115.8
4A	138.1	16.2	118.8
4B	138.6	14.9	120.7
2A	137.1	17.9	116.6
5	135.5	12.0	121.0
7	136.1	12.3	121.2
9	136.1	12.7	120.8
13	136.2	12.2	121.4
4	138.7	11.1	124.8
11	142.0	10.6	128.3
6	134.9	8.4	124.4
8	125.3	8.8	115.1
8A	134.9	8.5	124.3
10	138.9	10.6	125.6
10A	133.7	11.6	119.8
12	141.6	9.5	129.3
1	129.0	15.4	111.8
2	127.1	14.8	110.7

TABLE 1

INCO NO.	DIAMETER (INCHES)	DATE CAST	AGE AT TEST	COMMENTS
9-A	2	Feb. 24/87	168 days	Triaxial-undrained
9-B	2	Feb. 24/87	168 days	Triaxial-undrained
11-A	2	Feb. 24/87	168 days	Triaxial-undrained

TABLE 2

INCO NO.	WET UNIT WEIGHT (p.c.f.)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (p.c.f.)
9-A	138.6	14.8	120.8
9-B	139.4	14.0	122.2
11-A	138.7	15.0	120.6

TABLE 1

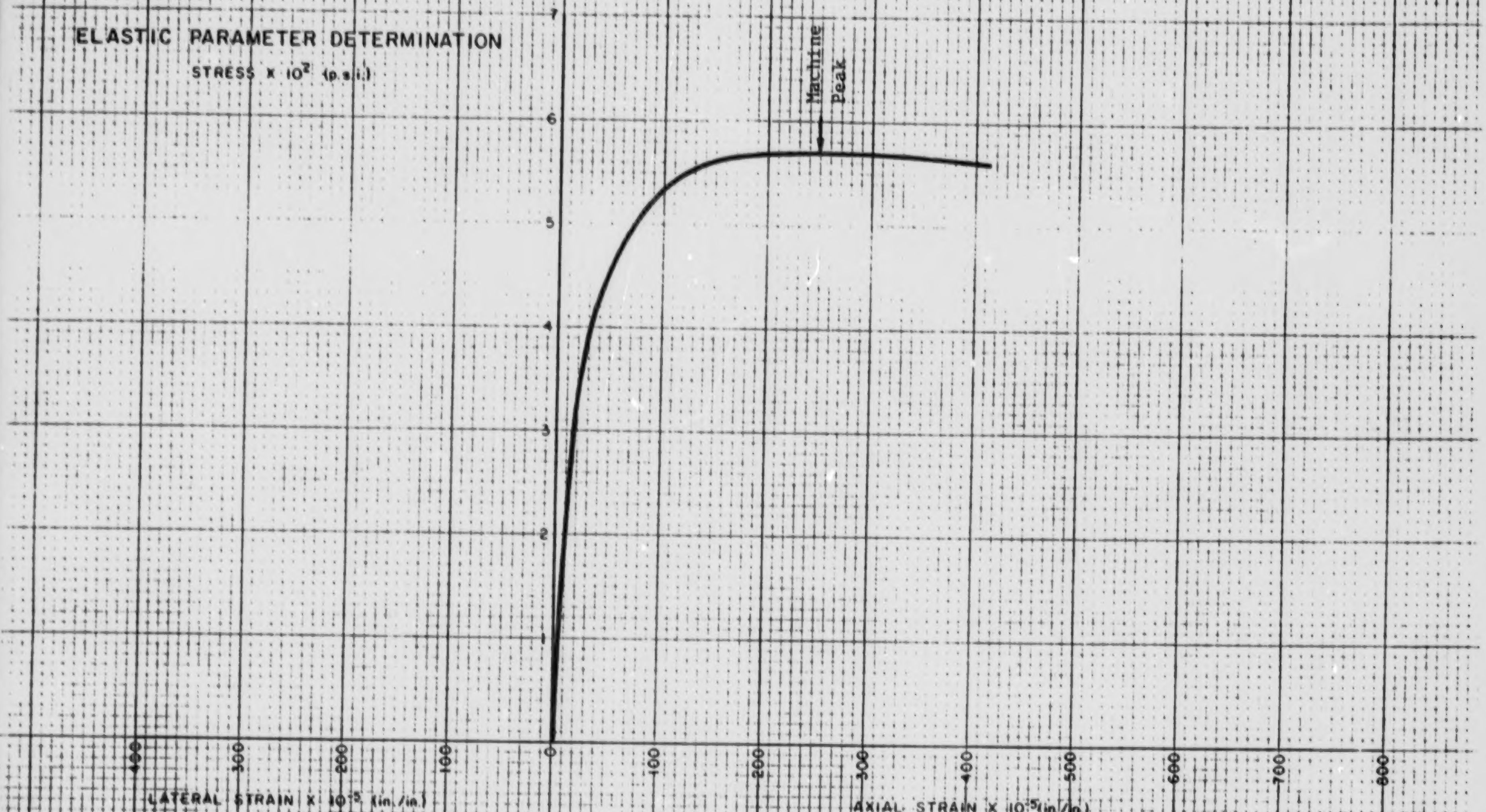
INCO NO.	DIAMETER (inches)	DATE CAST	AGE TESTED (days)	COMMENTS σ_3
8	1.95	April 9/87	183	25 psi
12	1.95	April 9/87	183	20 psi
14a	1.95	April 9/87	183	50 psi
14b	1.95	April 9/87	183	100 psi

TABLE 2

INCO. NO.	NET UNIT WEIGHT (p.c.f.)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (p.c.f.)
8	143.55	8.7	132.67
12	146.50	7.8	135.90
14a	143.71	9.9	132.82
14b	142.77	8.2	129.91

S861345M

ELASTIC PARAMETER DETERMINATION

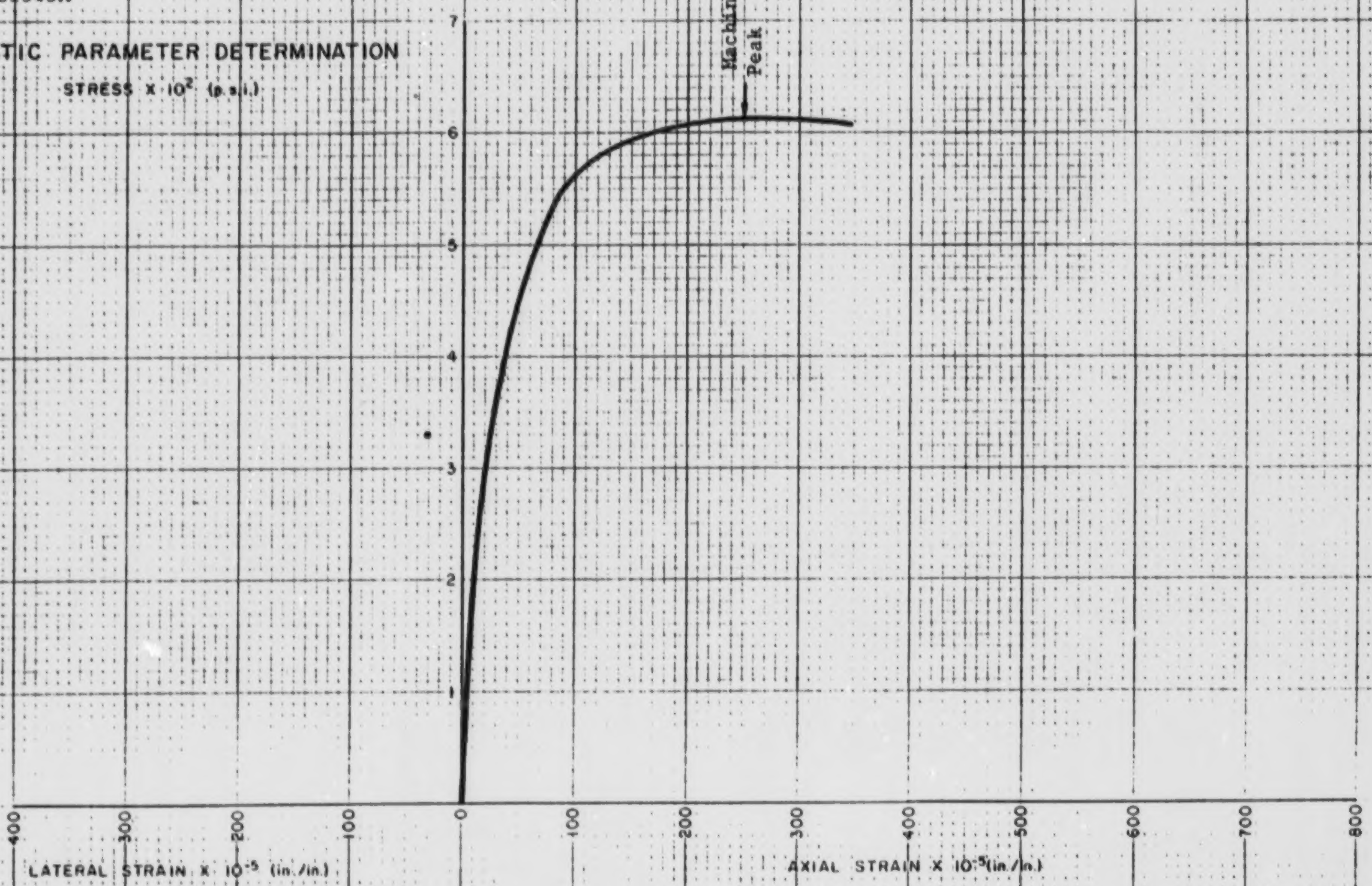


TEST № - L-6 (F)
CONDITION OF SAMPLE - ok
WET UNIT WEIGHT (p.c.f.) - 141.1
MOISTURE CONTENT (%) - 12.0
DRY UNIT WEIGHT (p.c.f.) - 126.0

DATE - Dec.8/86 AGE - 28 days
DIAMETER (in.) - 6
LENGTH (in.) - 11.5
COMPRESSIVE STRENGTH (p.s.i.) - 569

S861345M

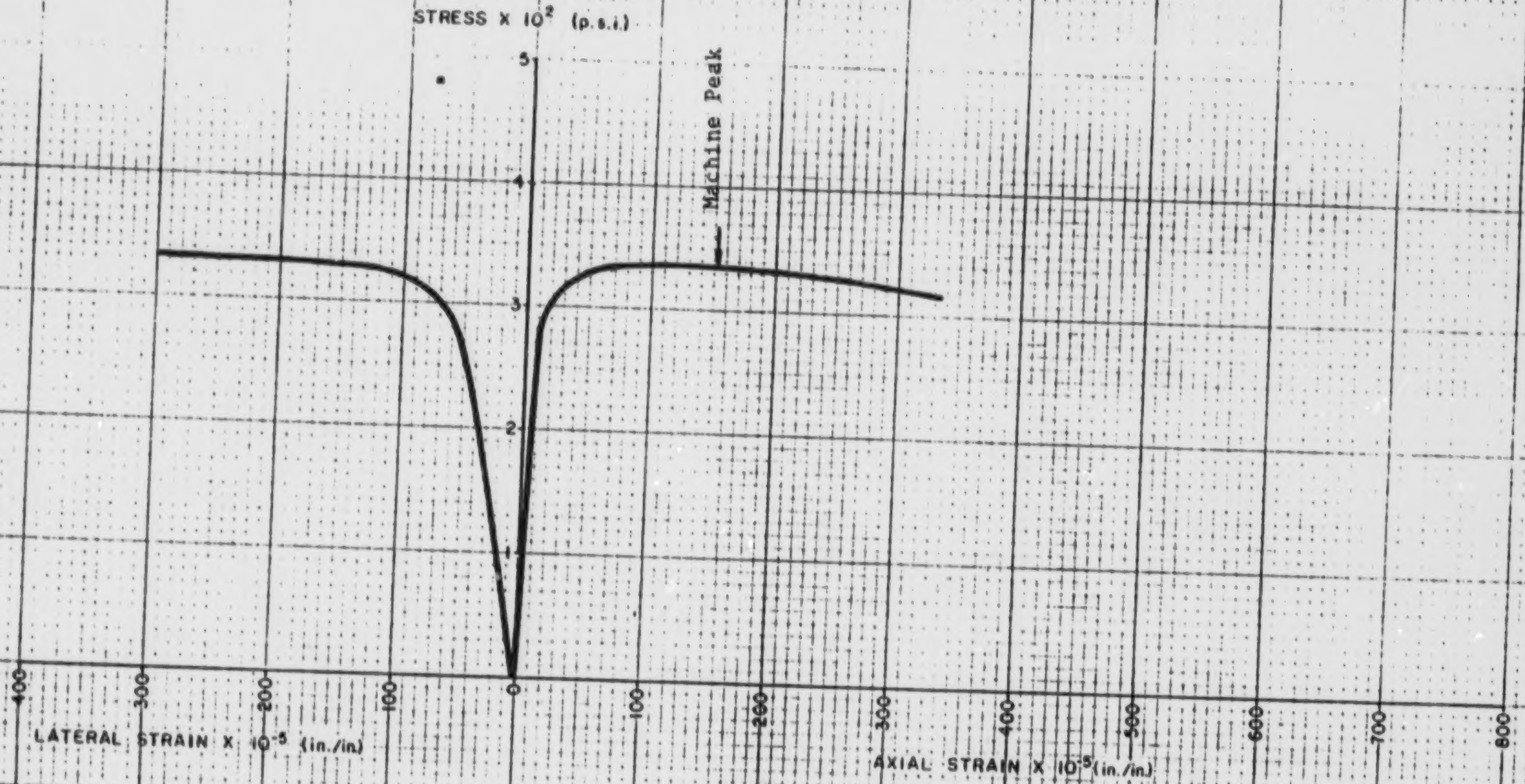
ELASTIC PARAMETER DETERMINATION



TEST Nº	L-7 (G)	DATE - Dec.8/86 AGE	28 days
CONDITION OF SAMPLE	surface voids	DIAMETER (in.)	6
WET UNIT WEIGHT (p.c.f.)	140.0	LENGTH (in.)	11.5
MOISTURE CONTENT (%)	11.0	COMPRESSIVE STRENGTH (p.s.i.)	611
DRY UNIT WEIGHT (p.c.f.)	126.1		

S861345M

ELASTIC PARAMETER DETERMINATION

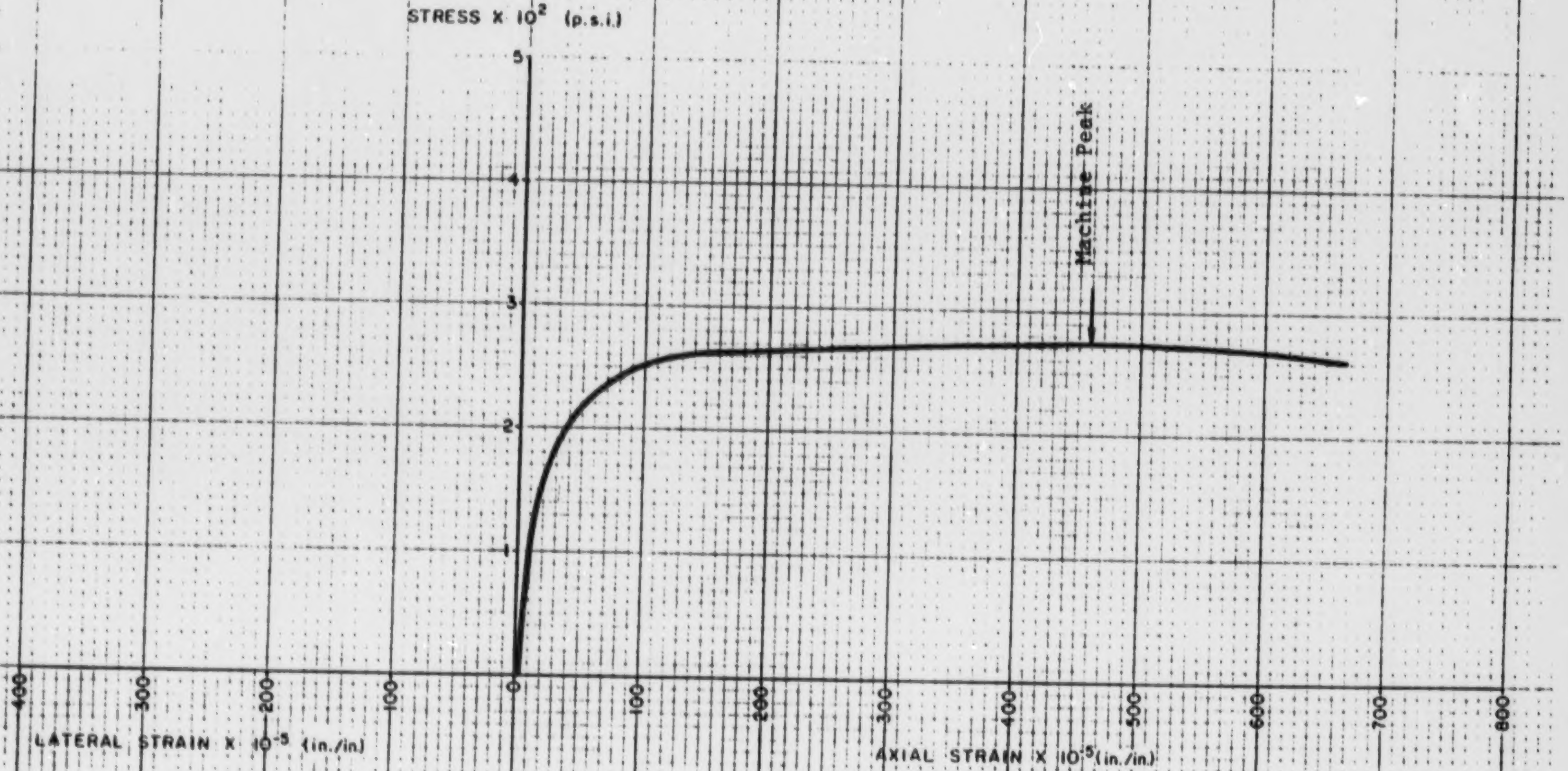


TEST Nº – L-2D (I)
CONDITION OF SAMPLE – ok
WET UNIT WEIGHT (p.c.f.) – 138.7
MOISTURE CONTENT (%) – 9.0
DRY UNIT WEIGHT (p.c.f.) – 127.2

DATE – Nov.26/86 AGE – 7 days
DIAMETER (in.) – 6
LENGTH (in.) – 11.61
COMPRESSIVE STRENGTH (p.s.i.) – 335

S861345M

ELASTIC PARAMETER DETERMINATION

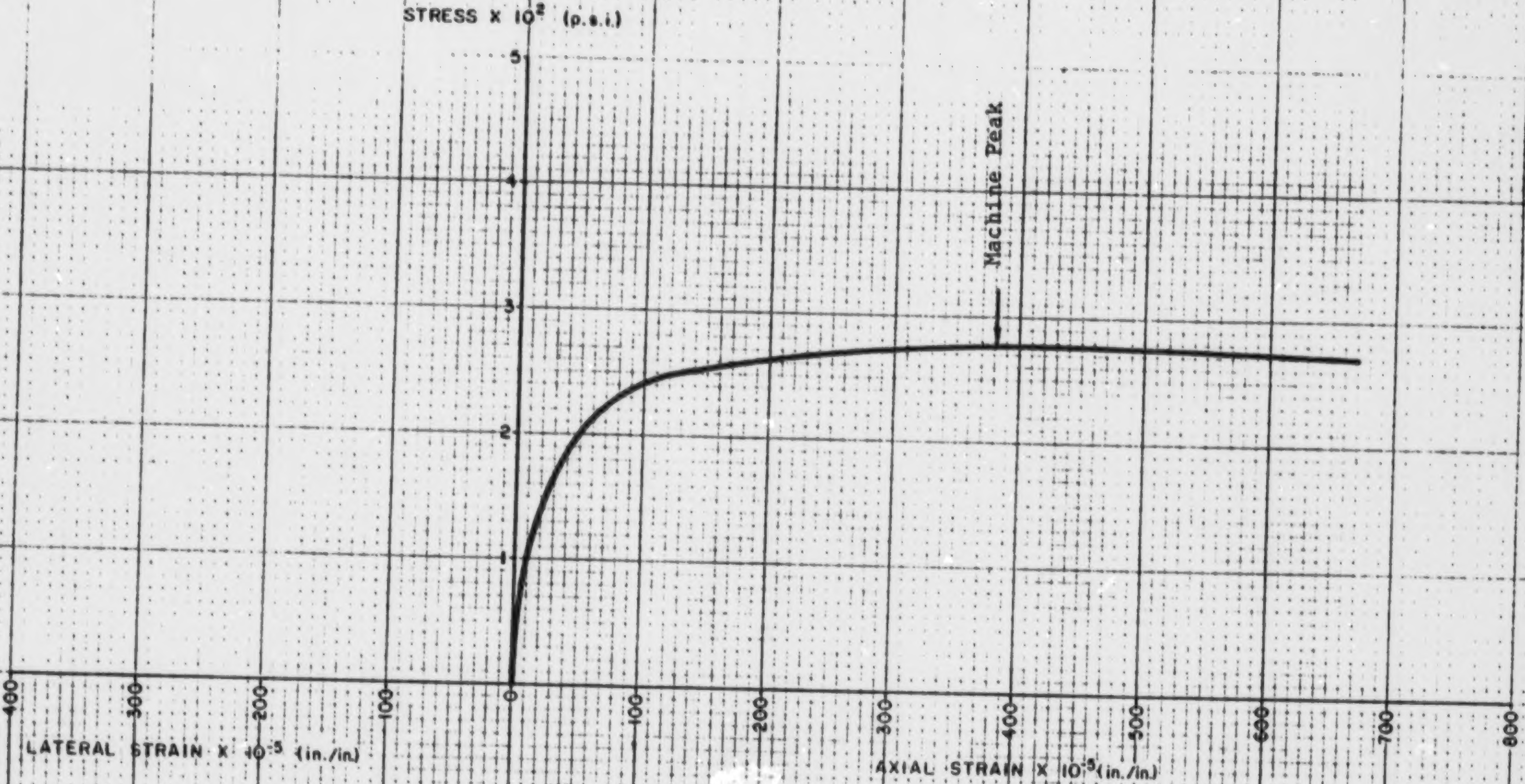


TEST Nº - L-21 (2)
CONDITION OF SAMPLE - ok
WET UNIT WEIGHT (p.c.f.) - 137.0
MOISTURE CONTENT (%) - 10.5
DRY UNIT WEIGHT (p.c.f.) - 124.0

DATE - Nov.26/86 AGE - 7 days
DIAMETER (in.) - 6
LENGTH (in.) - 10.82
COMPRESSIVE STRENGTH (p.s.i.) - 274

S861345M

ELASTIC PARAMETER DETERMINATION



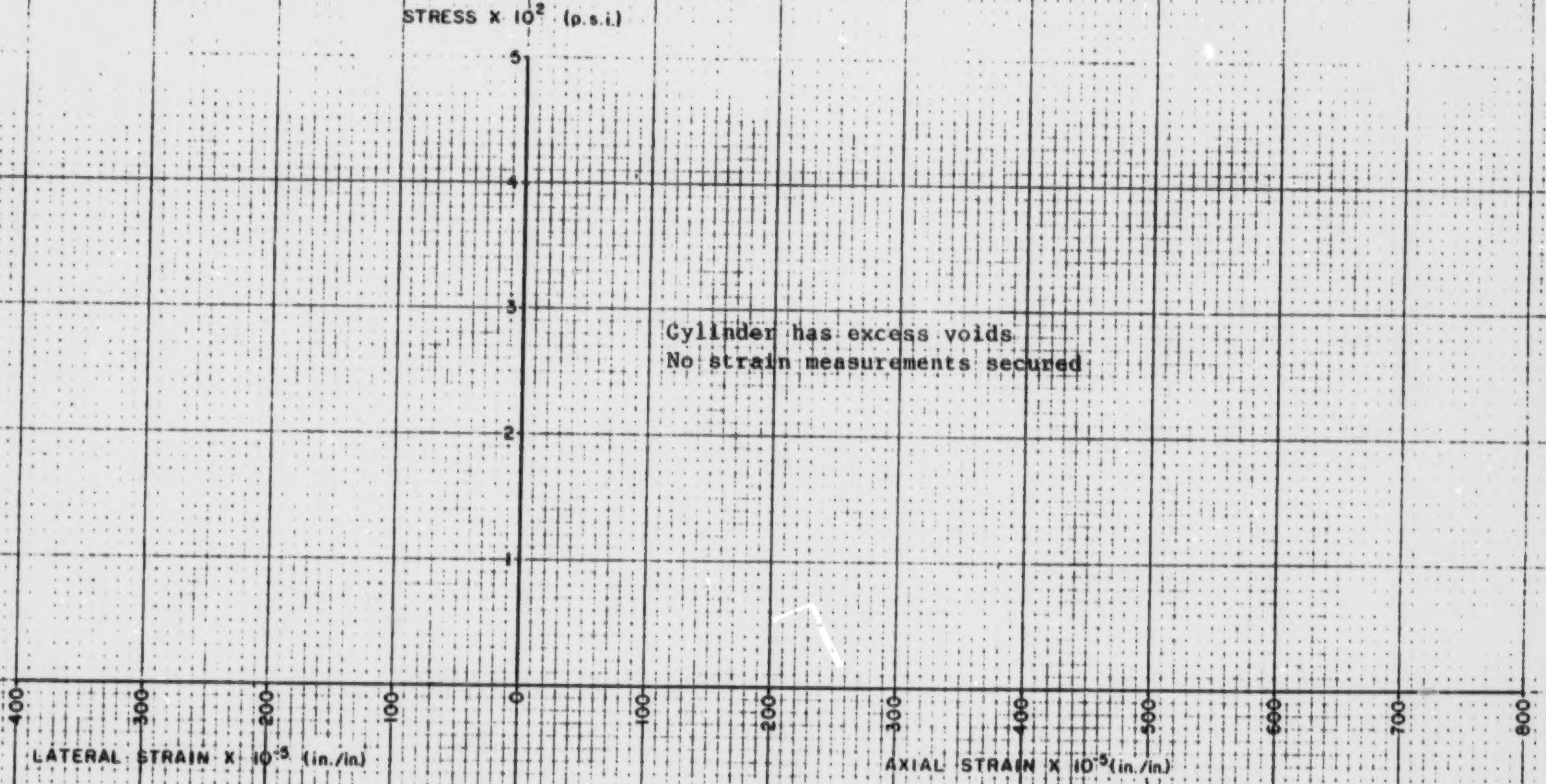
TEST Nº	→ L-22 (4)
CONDITION OF SAMPLE	→ ok, occ. voids
WET UNIT WEIGHT (p.c.f.)	→ 136.2
MOISTURE CONTENT (%)	→ 9.2
DRY UNIT WEIGHT (p.c.f.)	→ 124.7

DATE – Nov.26/86

AGE	→ 7 days
DIAMETER (in.)	→ 6
LENGTH (in.)	→ 9.84
COMPRESSIVE STRENGTH (p.s.i.)	→ 278

S861345M

ELASTIC PARAMETER DETERMINATION



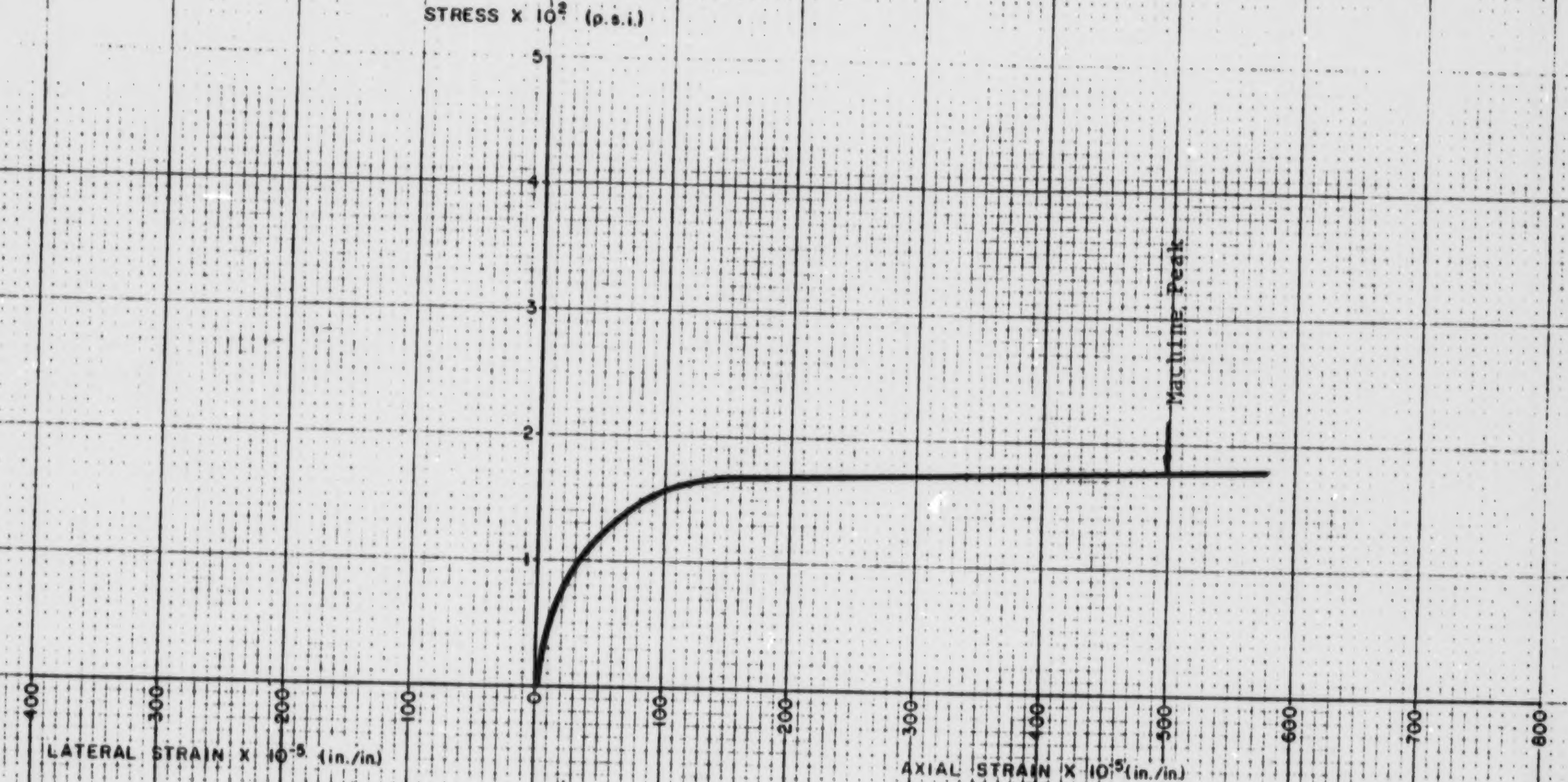
Cylinder has excess voids
No strain measurements secured

TEST Nº – L-23 (5)
CONDITION OF SAMPLE – voids
WET UNIT WEIGHT (p.c.f.) – 140.0
MOISTURE CONTENT (%) – 13.1
DRY UNIT WEIGHT (p.c.f.) – 123.9

DATE – Nov.26/86 AGE – 7 days
DIAMETER (in.) – 6
LENGTH (in.) – 11.02
COMPRESSIVE STRENGTH (p.s.i.) – 220.0

S861345M

ELASTIC PARAMETER DETERMINATION

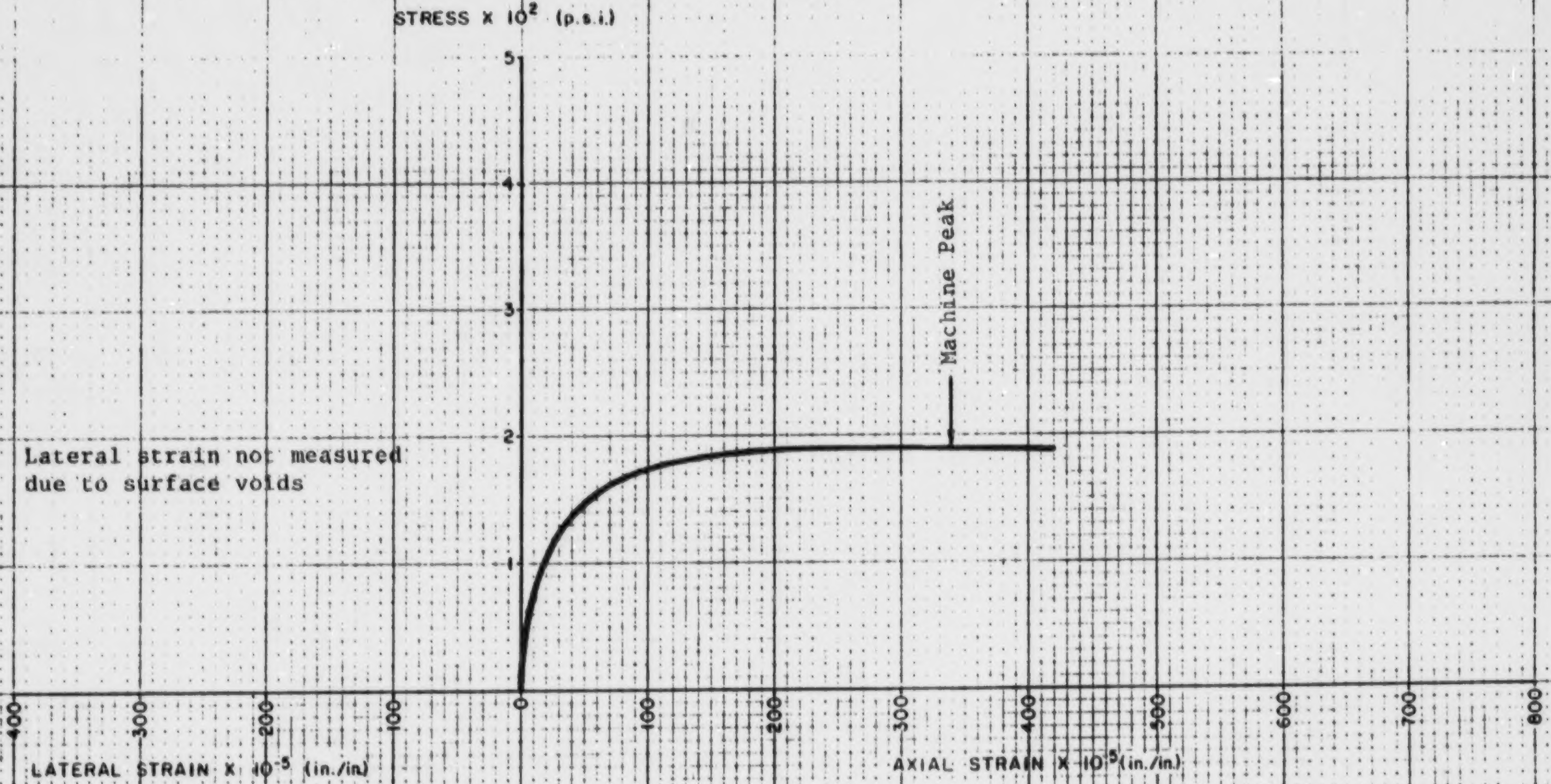


TEST Nº – L-24 (7)
CONDITION OF SAMPLE – ok
WET UNIT WEIGHT (p.c.f.) – 138.2
MOISTURE CONTENT (%) – 12.5
DRY UNIT WEIGHT (p.c.f.) – 123.1

DATE – Nov.26/86 AGE – 7 days
DIAMETER (in.) – 6
LENGTH (in.) – 11.81
COMPRESSIVE STRENGTH (p.s.i.) – 180

S861345M

ELASTIC PARAMETER DETERMINATION



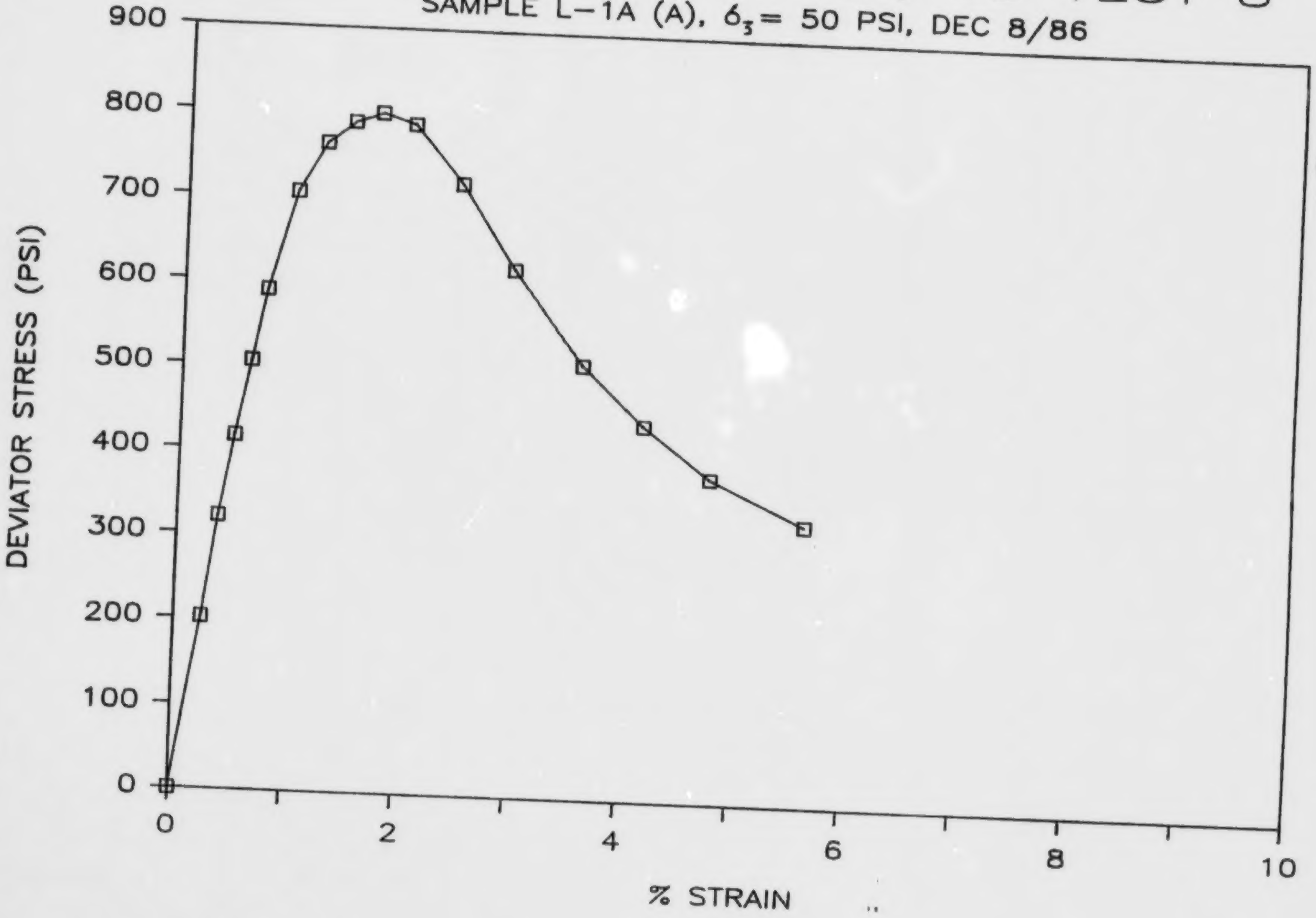
Lateral strain not measured due to surface voids

TEST Nº – L-25 (8)
CONDITION OF SAMPLE – voids
WET UNIT WEIGHT (p.c.f.) – 136.5
MOISTURE CONTENT (%) – 12.9
DRY UNIT WEIGHT (p.c.f.) – 120.9

DATE – Nov.26/86 AGE 7 day
DIAMETER (in.) – 6
LENGTH (in.) – 11.61
COMPRESSIVE STRENGTH (p.s.i.) – 193.5

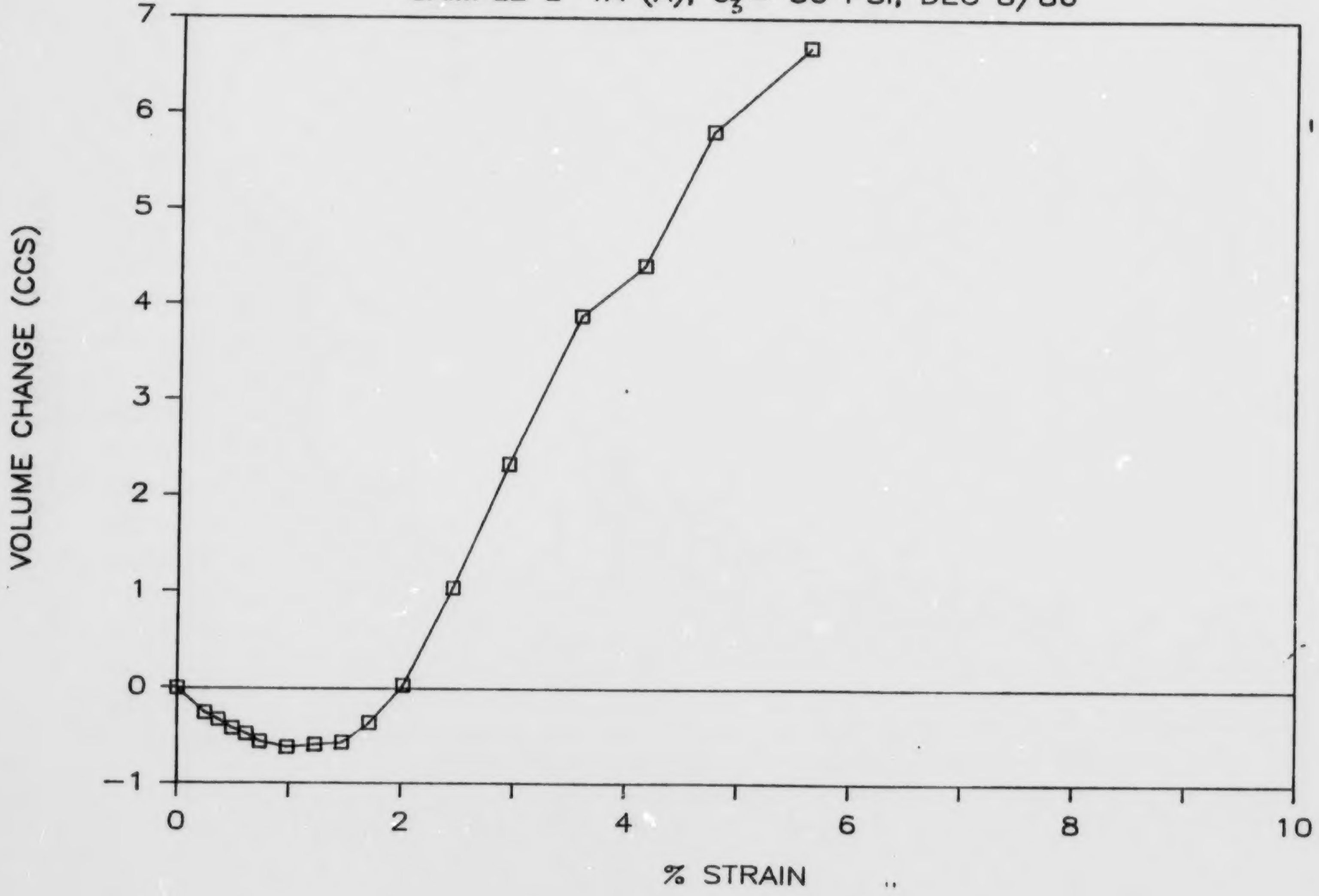
INCO—MINE BACKFILL, CD TEST 8

SAMPLE L—1A (A), σ_3= 50 PSI, DEC 8/86



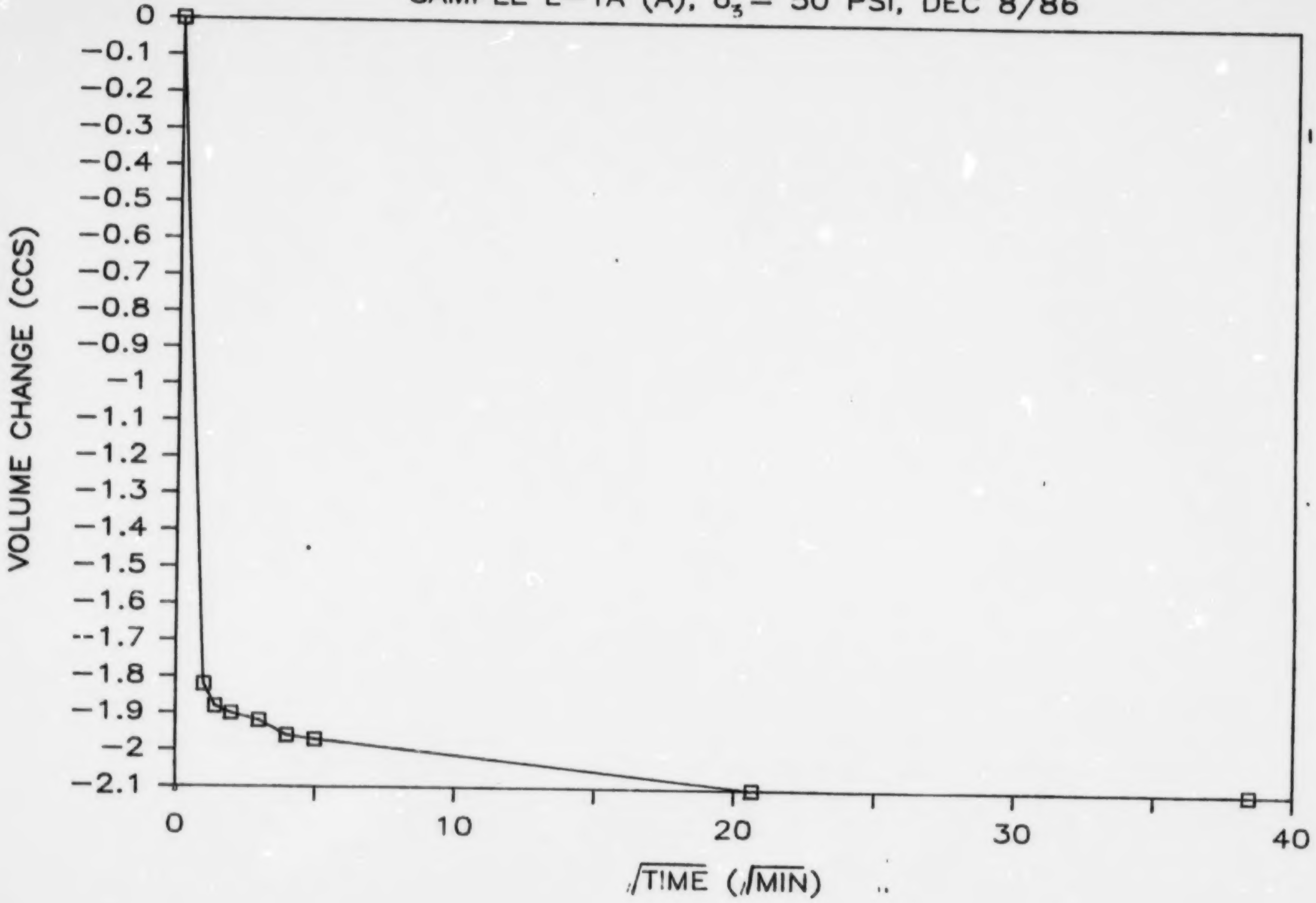
INCO—MINE BACKFILL, CD TEST 8

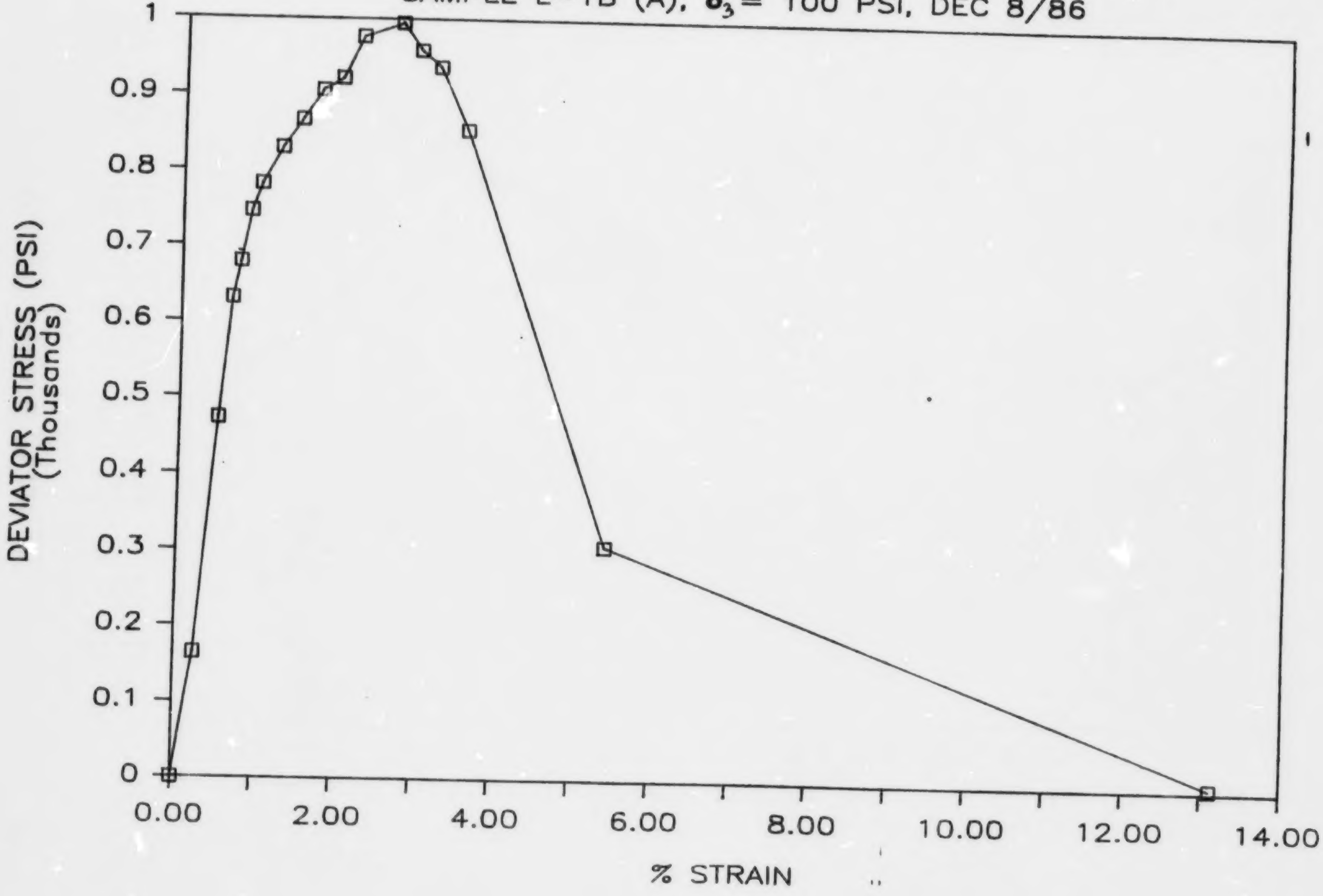
SAMPLE L—1A (A), σ_3= 50 PSI, DEC 8/86



INCO—MINE BACKFILL, CD TEST 8

SAMPLE L—1A (A), 6_3= 50 PSI, DEC 8/86



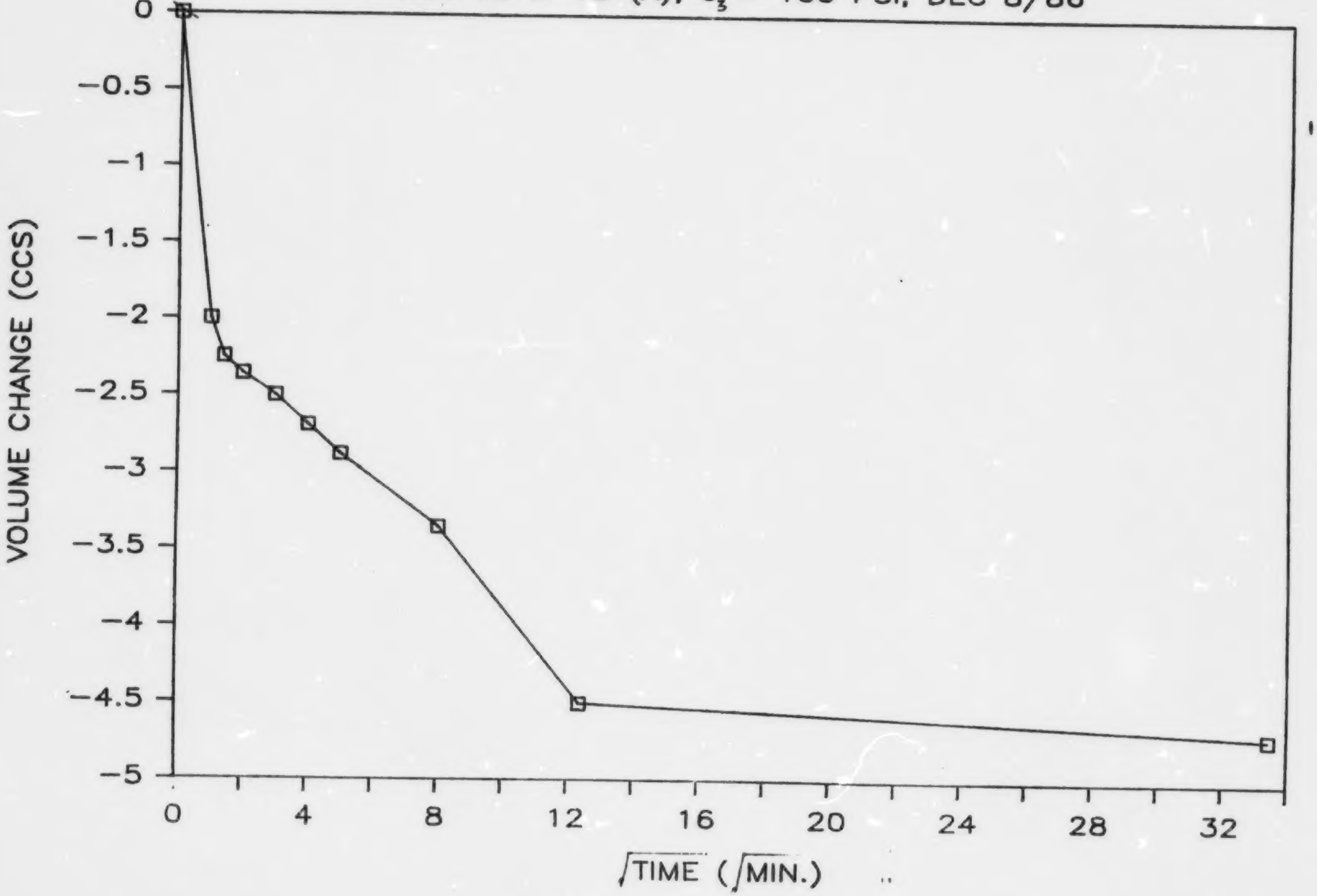


INCO—MINE BACKFILL, CD TEST 9

SAMPLE L—1B (A), σ_3= 100 PSI, DEC 8/86

INCO—MINE BACKFILL, CD TEST 9

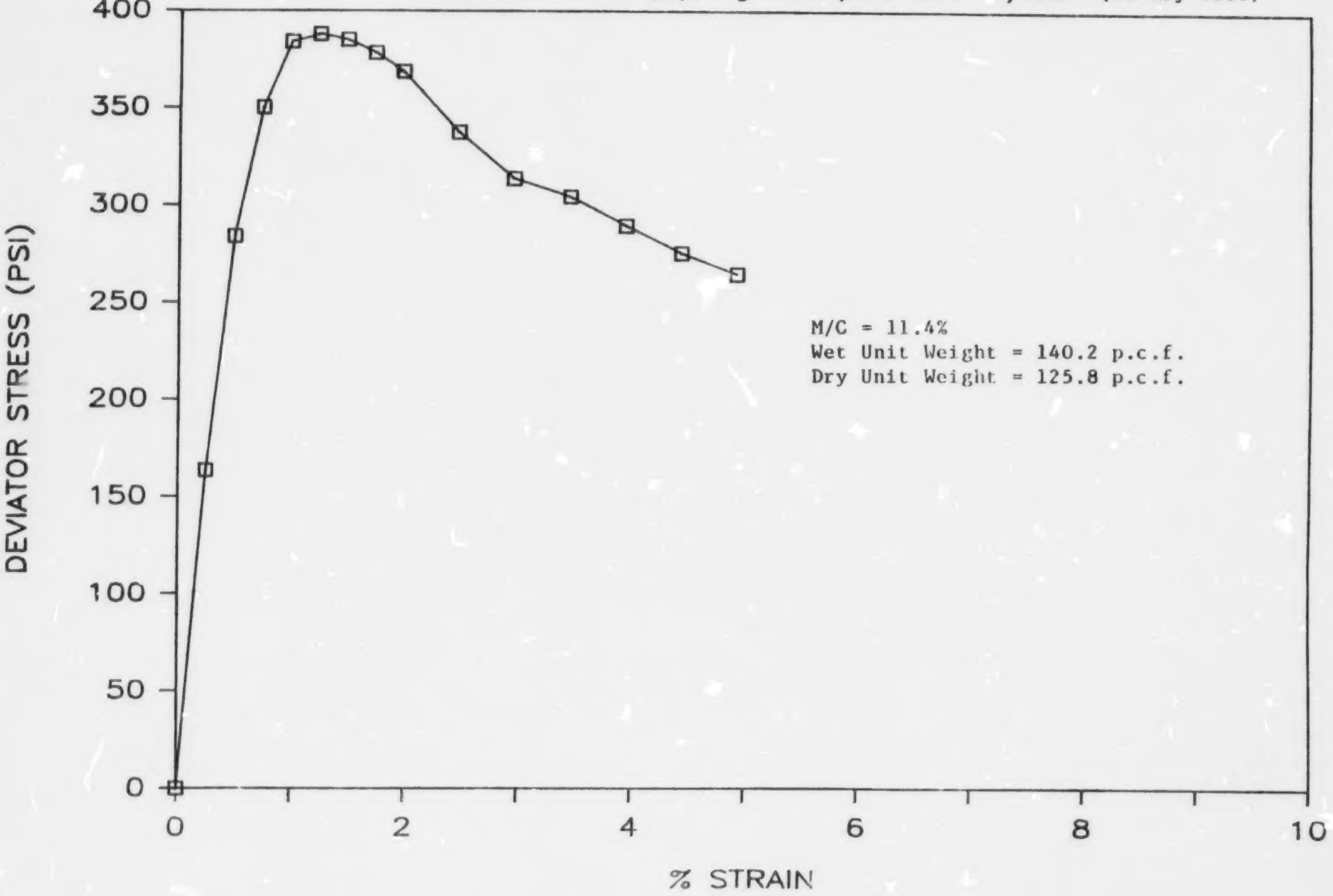
SAMPLE L—1B (A), σ_3 = 100 PSI, DEC 8/86



S861345M

INCO MINE—BACKFILL, UU TEST #5

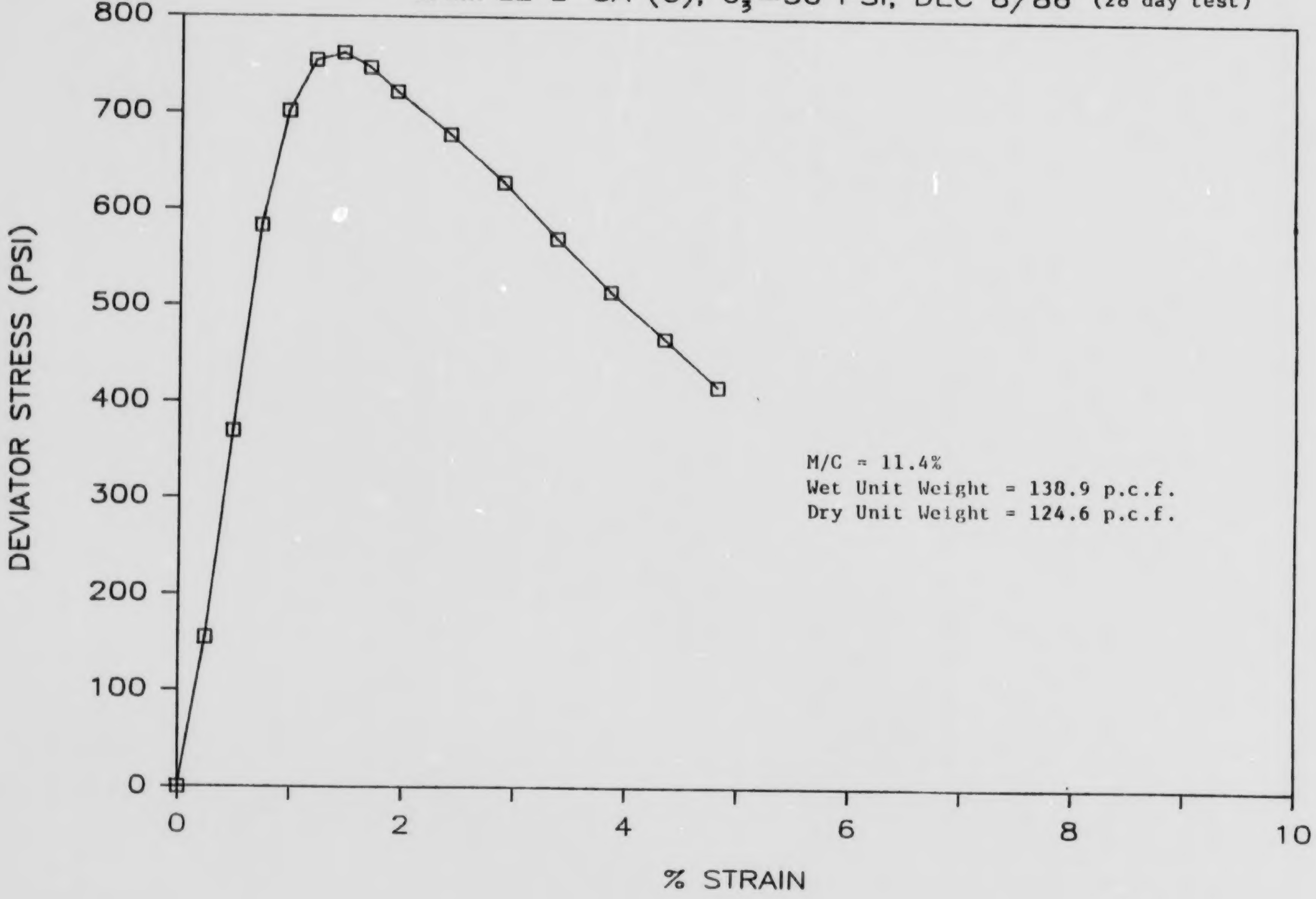
SAMPLE L–2 (B), σ_3=25 psi, DEC 8/86 (28 day test)



S861345M

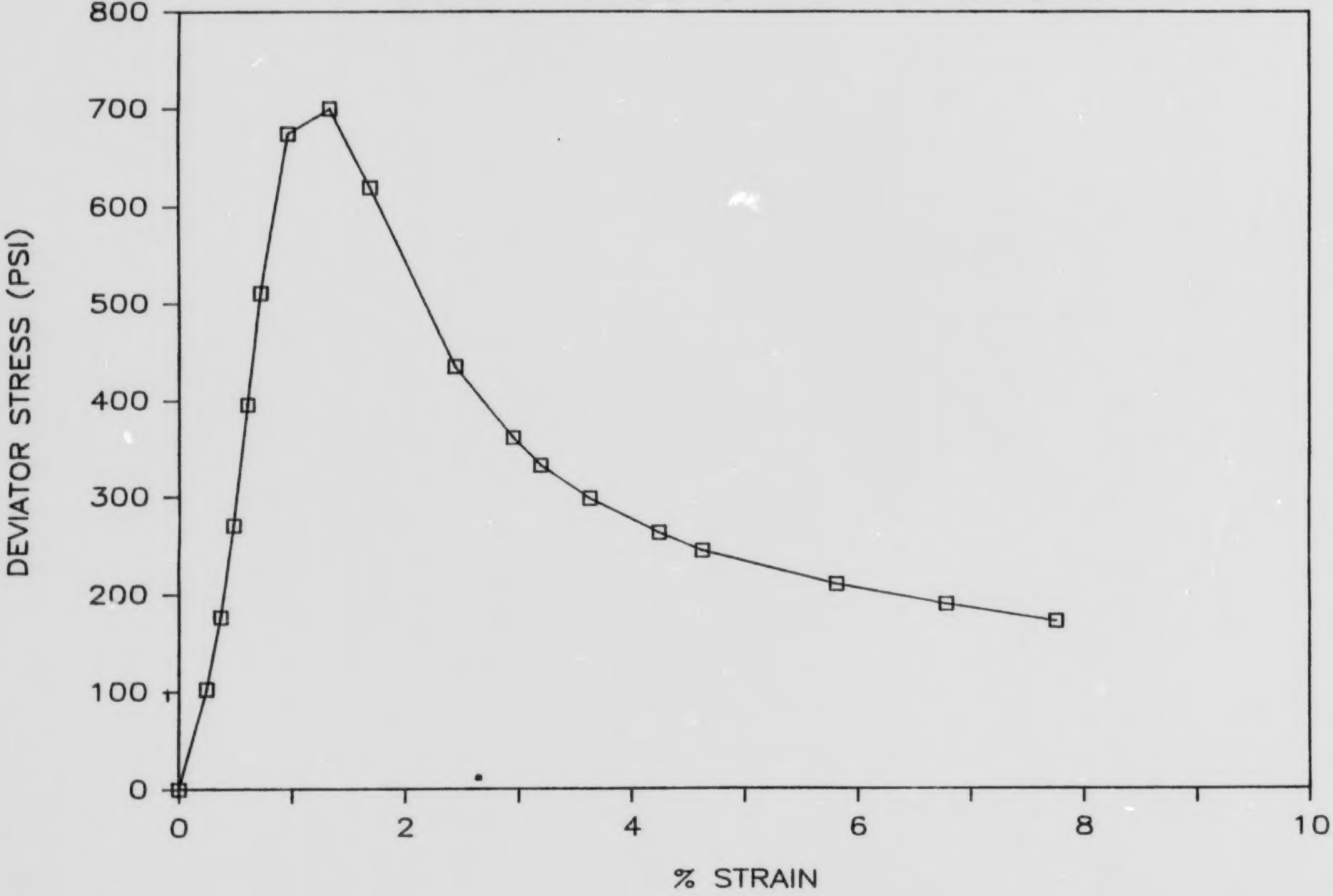
INCO—MINE BACKFILL, UU TEST #6

SAMPLE L—3A (C), σ_3=50 PSI, DEC 8/86 (28 day test)



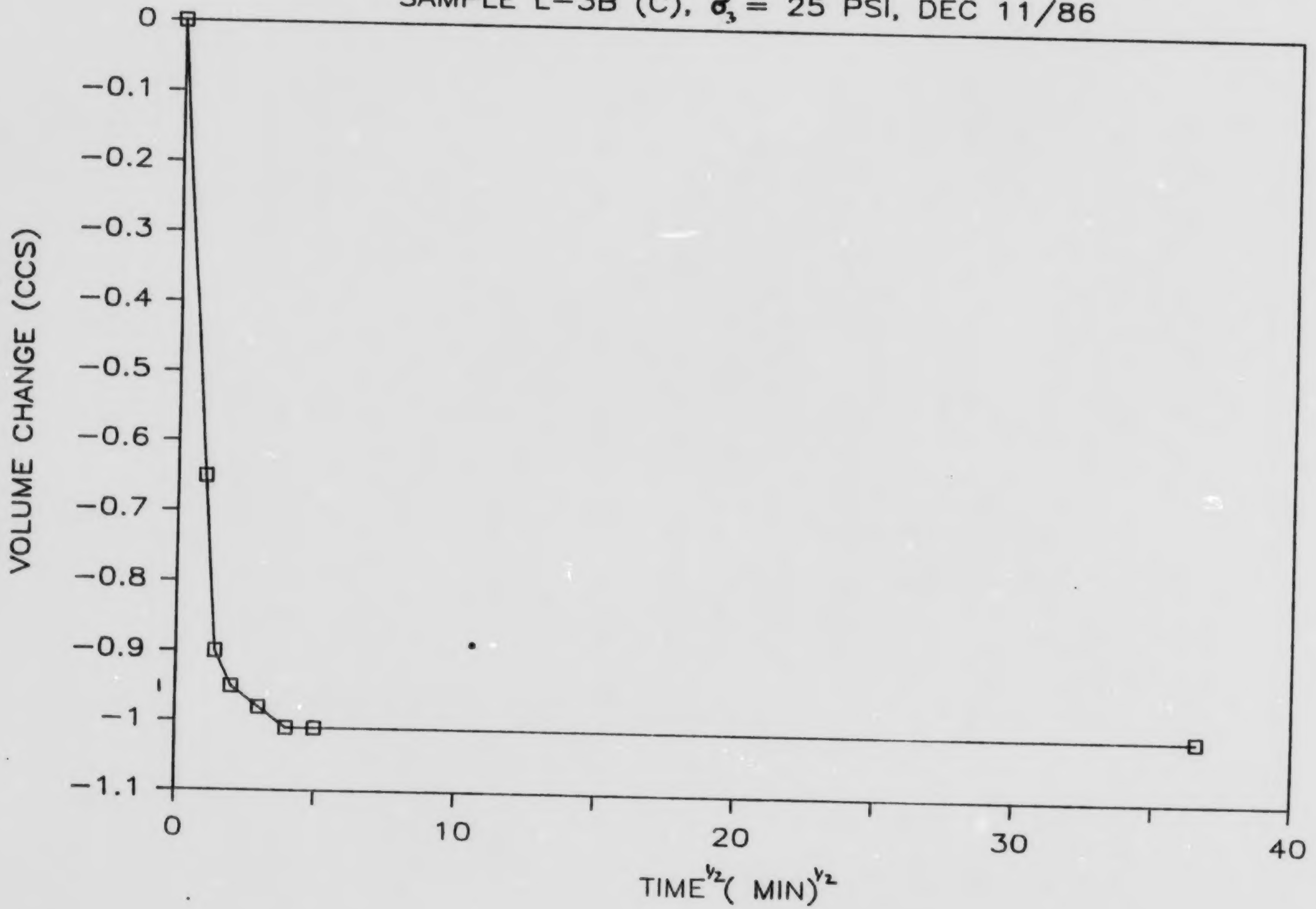
INCO—MINE BACKFILL, CD TEST 7

SAMPLE L—3B (C), σ_3 = 25 PSI, DEC 11/86



INCO—MINE BACKFILL, CD TEST 7

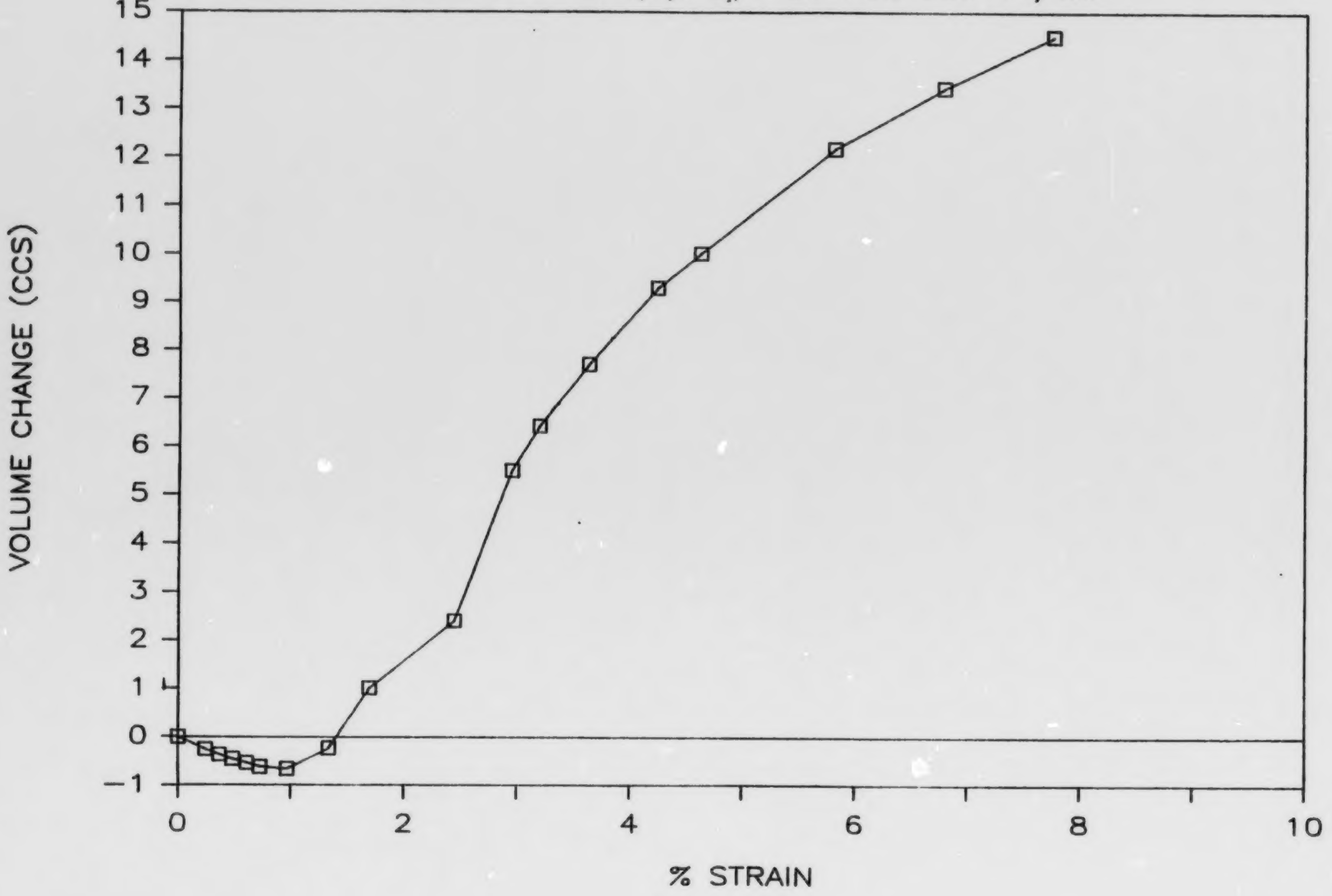
SAMPLE L–3B (C), σ_3 = 25 PSI, DEC 11/86

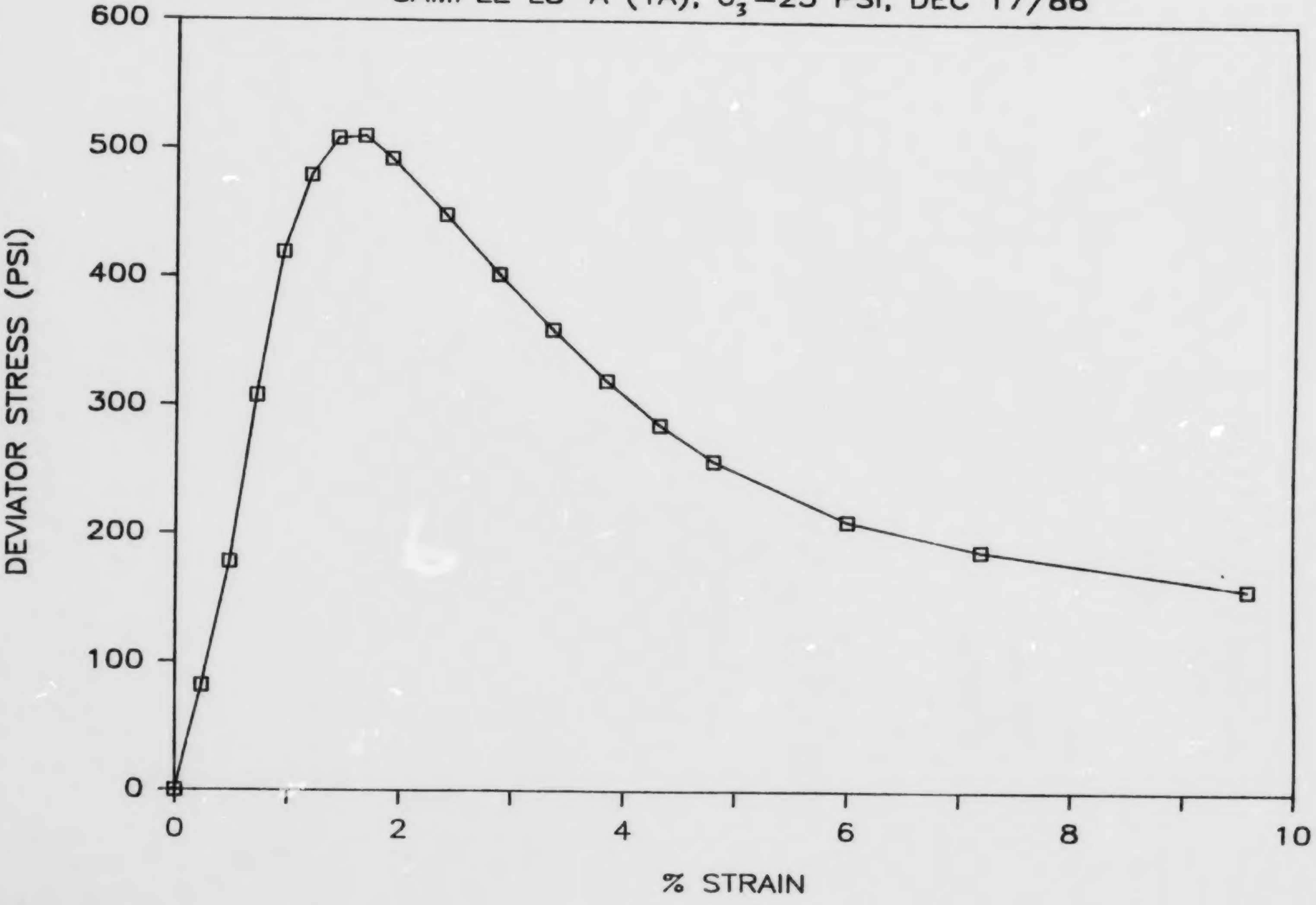


Trow

INCO—MINE "BACKFILL, CD TEST 7

SAMPLE L--3B (C), σ_3 = 25 PSI, DEC 11/86



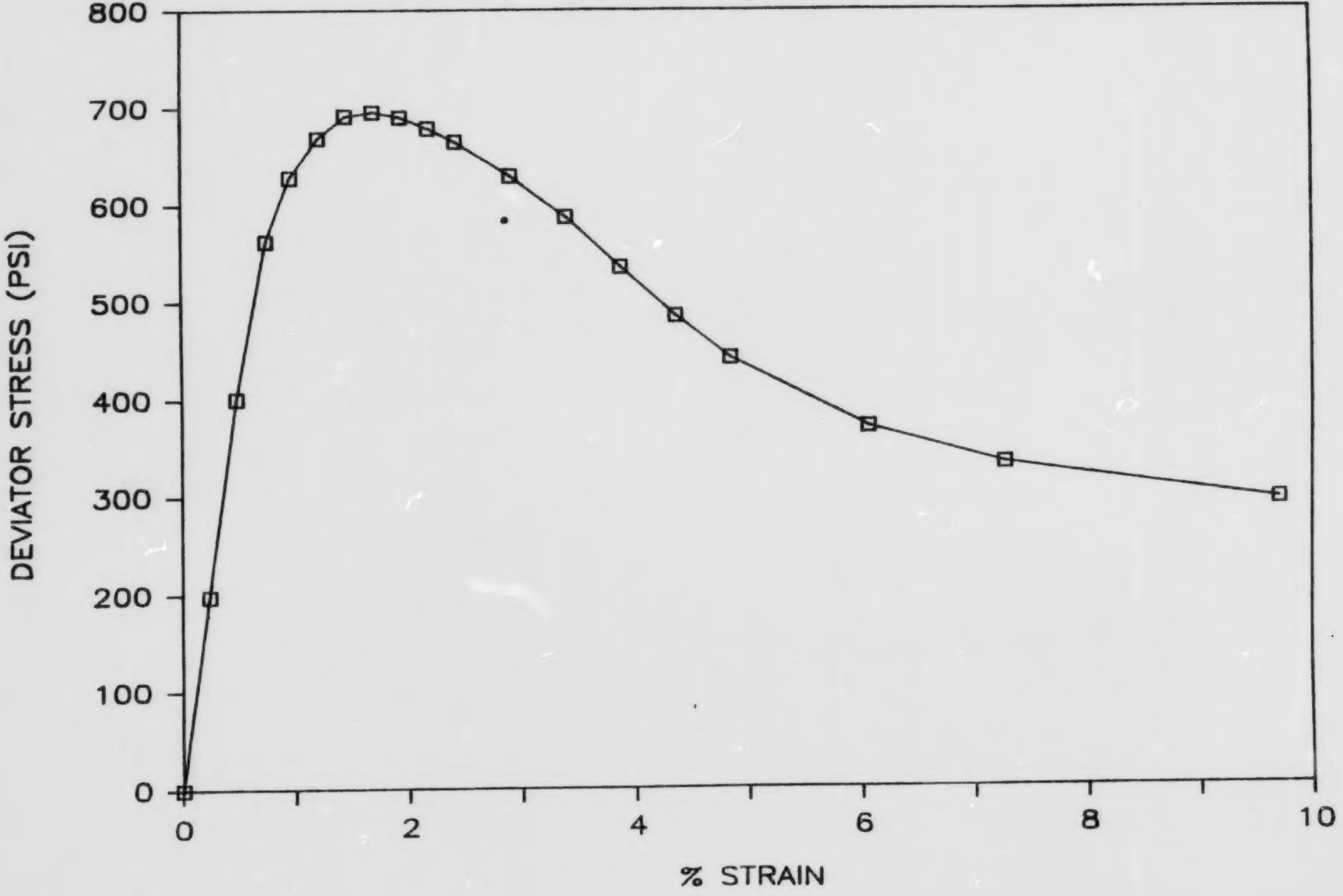


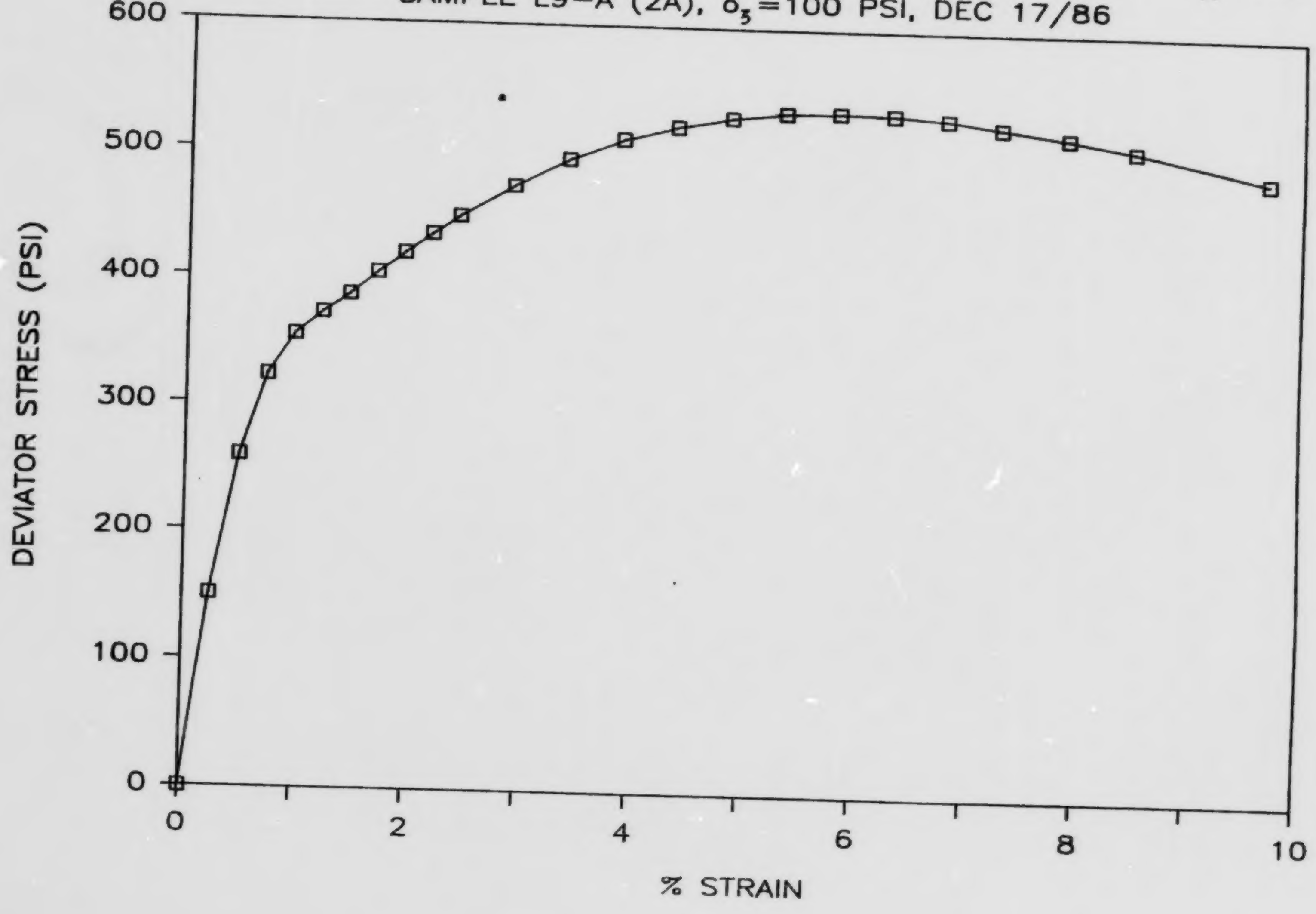
INCO–MINE BACKFILL, UU TEST #10

SAMPLE L8–A (1A), σ_3=25 PSI, DEC 17/86

INCO—MINE BACKFILL, UU TEST #11

SAMPLE L8—B (1B), σ_3=50 PSI, DEC 17/86

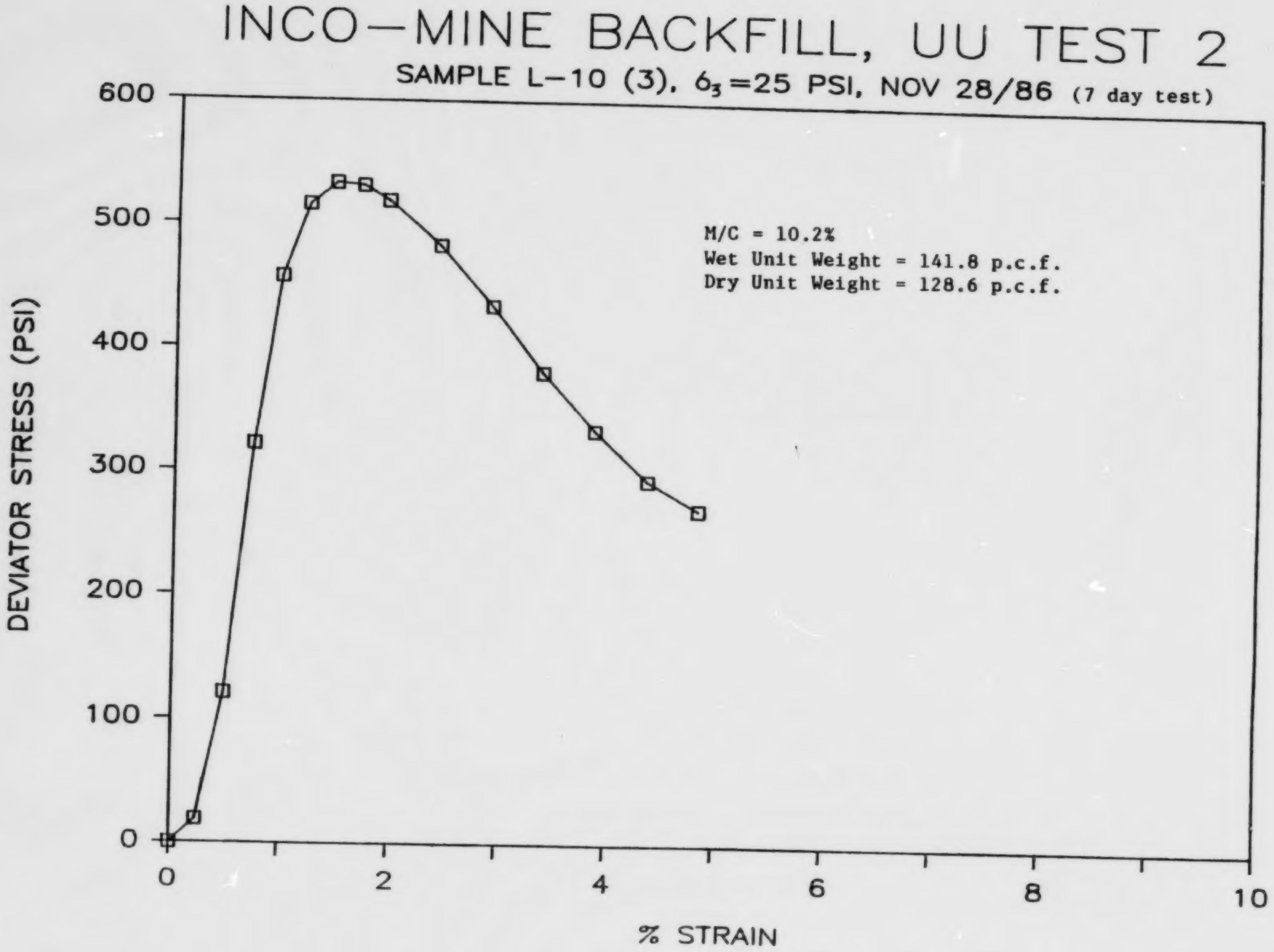




INCO—MINE BACKFILL, UU TEST #12

SAMPLE L9—A (2A), σ_3=100 PSI, DEC 17/86

S861345M



INCO—MINE BACKFILL, UU TEST 2

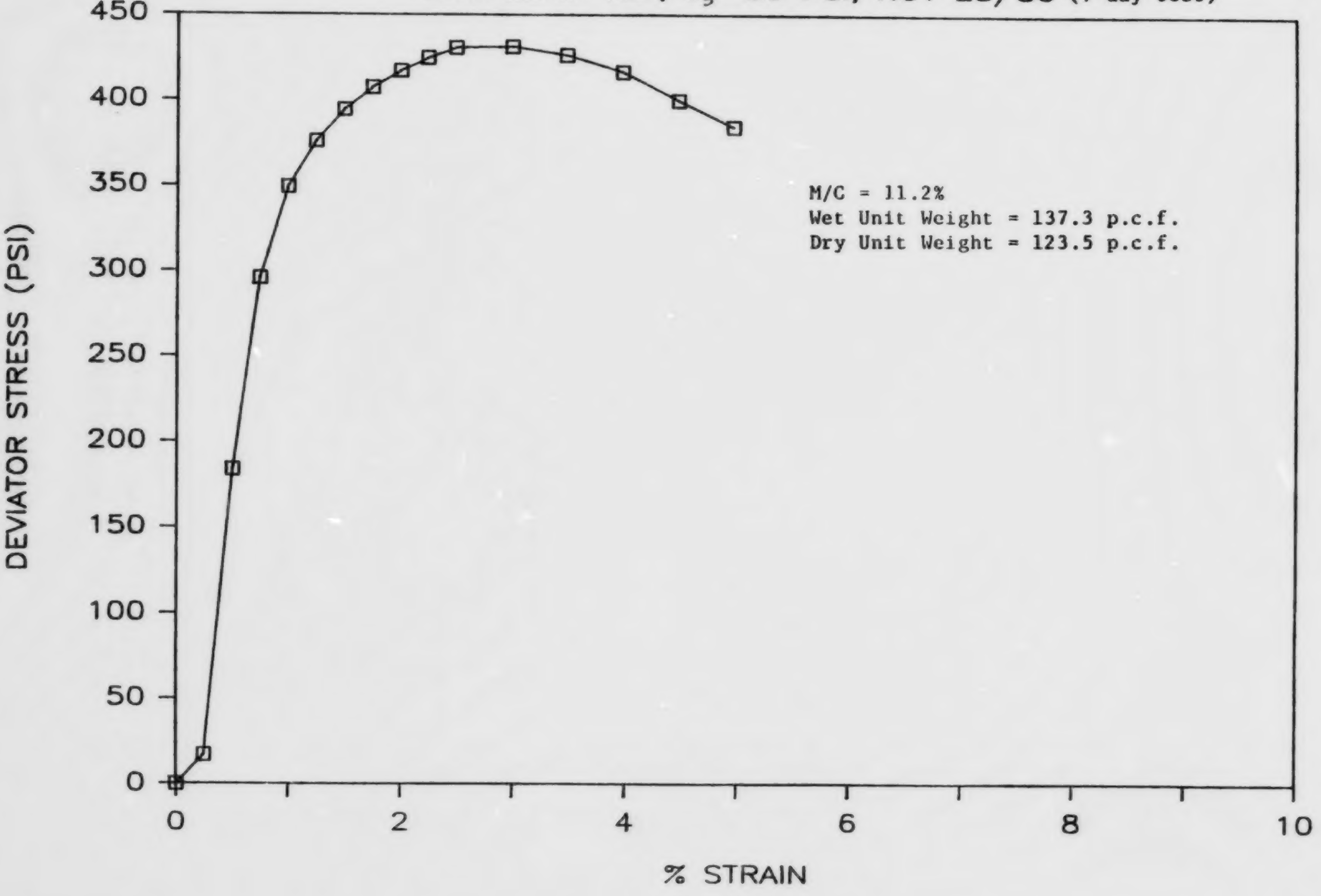
SAMPLE L—10 (3). σ_3=25 PSI, NOV 28/86 (7 day test)

M/C = 10.2%
Wet Unit Weight = 141.8 p.c.f.
Dry Unit Weight = 128.6 p.c.f.

S861345M

INCO—MINE BACKFILL, UU TEST 3

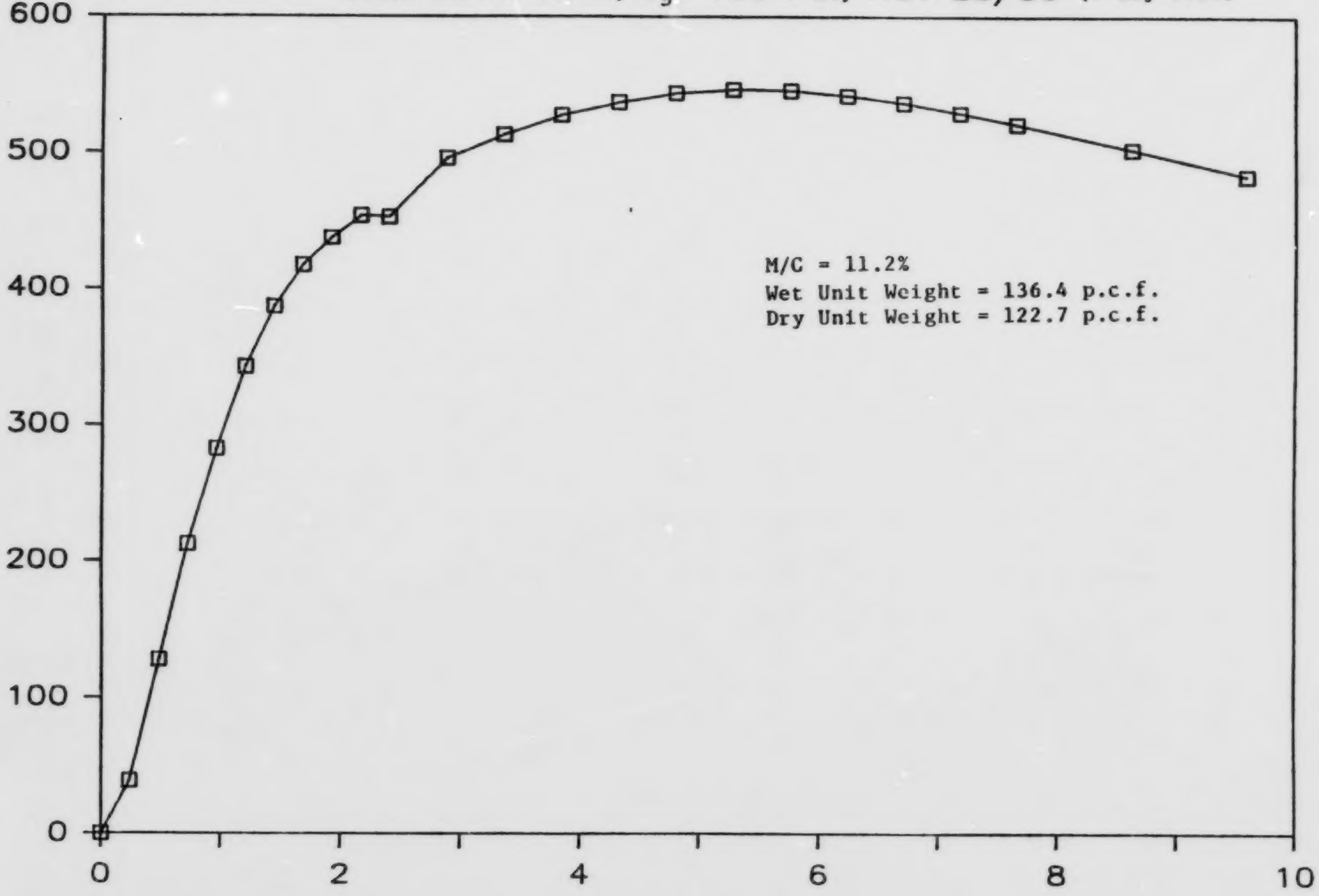
SAMPLE L—12A, σ_3=50 PSI, NOV 28/86 (7 day test)



S861345M

INCO—MINE BACKFILL, UU TEST 4

SAMPLE L—12 B, σ_3=100 PSI, NOV 28/86 (7 day test)

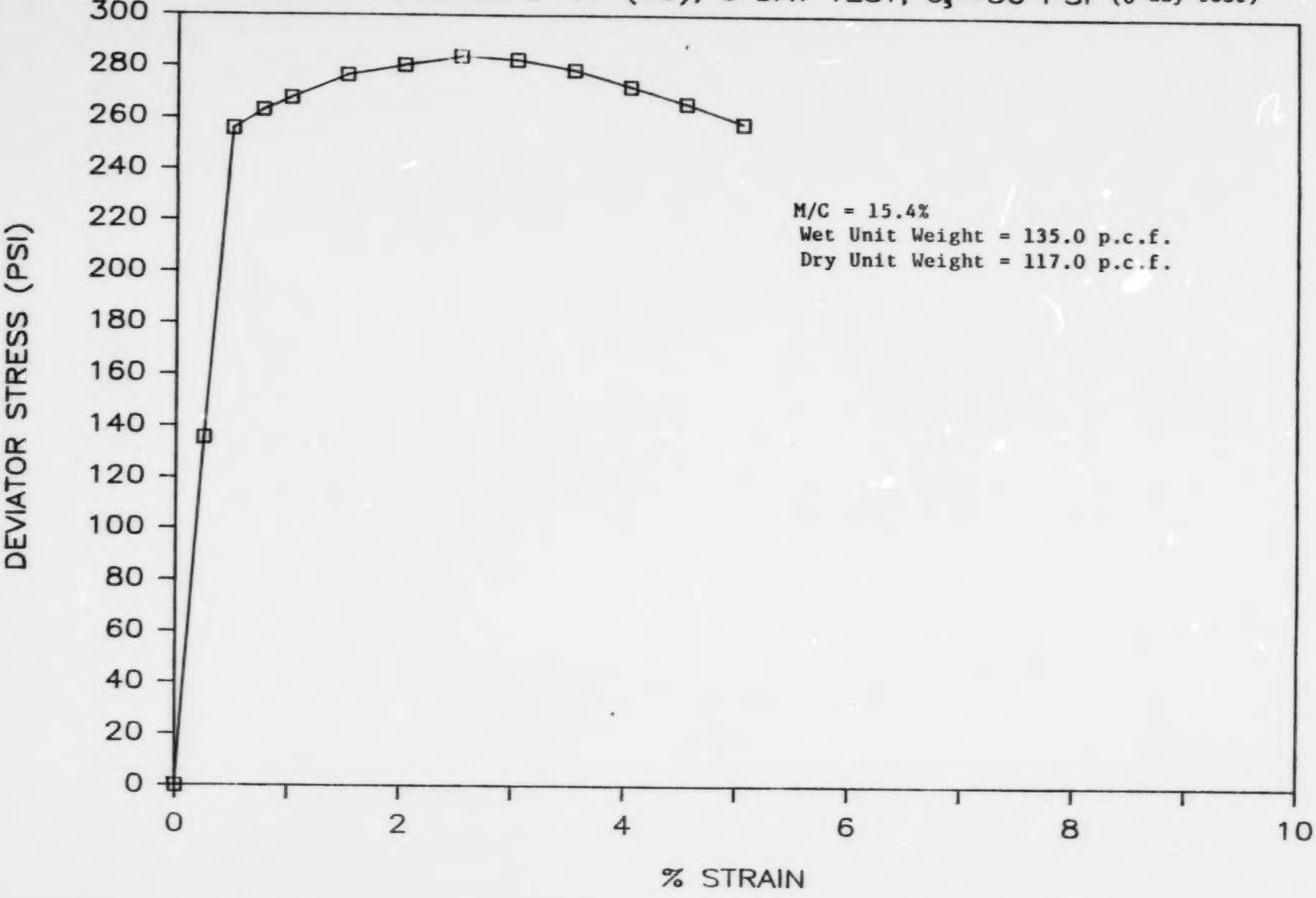


M/C = 11.2%
Wet Unit Weight = 136.4 p.c.f.
Dry Unit Weight = 122.7 p.c.f.

S861345M

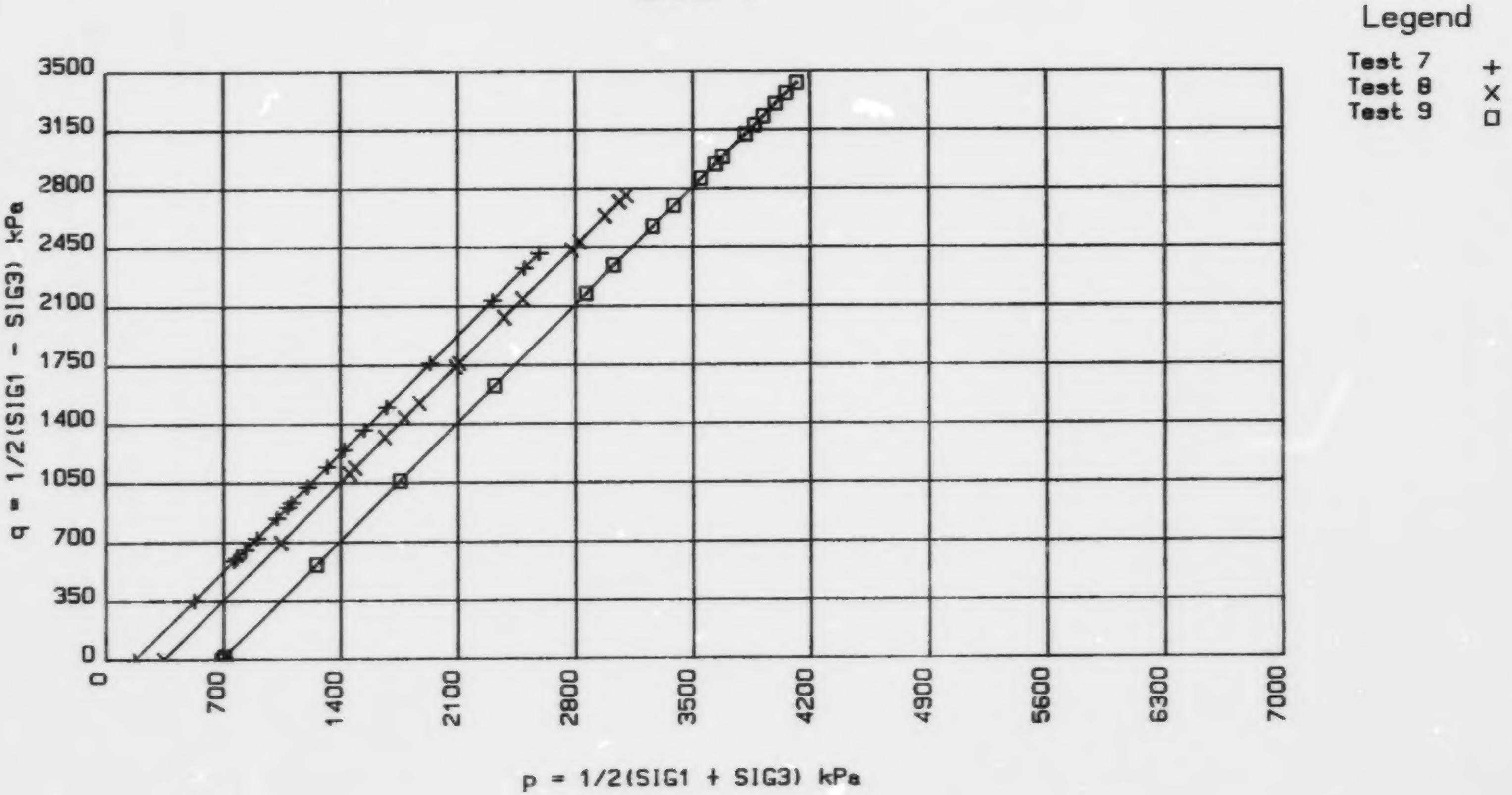
INCO—MINE BACKFILL, UU TEST 1

SAMPLE L–17 (10), 6 DAY TEST, σ_3 =30 PSI (6 day test)



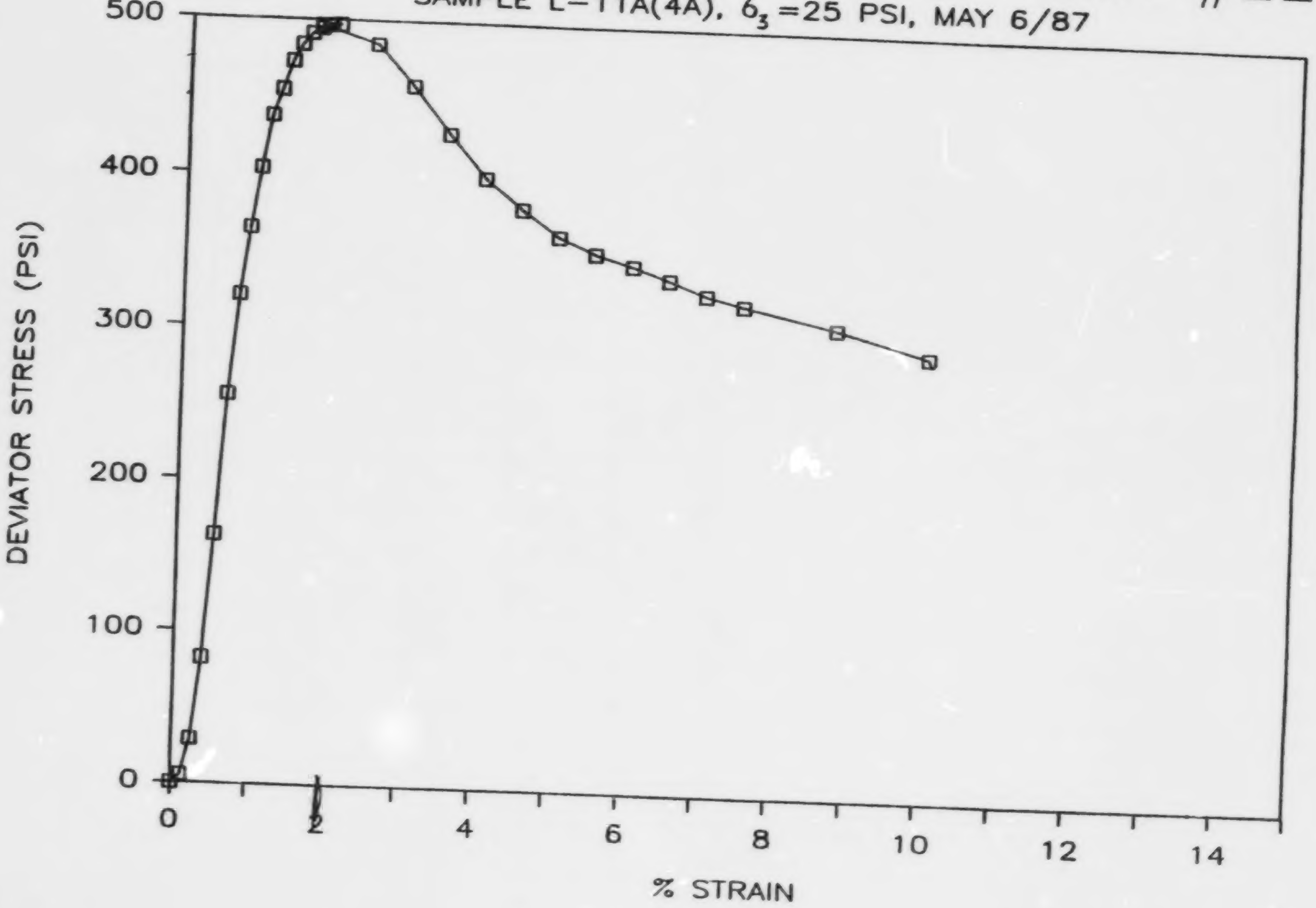
M/C = 15.4%
Wet Unit Weight = 135.0 p.c.f.
Dry Unit Weight = 117.0 p.c.f.

STRESS PATH
CD TESTS: INCO-MINE BACKFILL
GROUP I



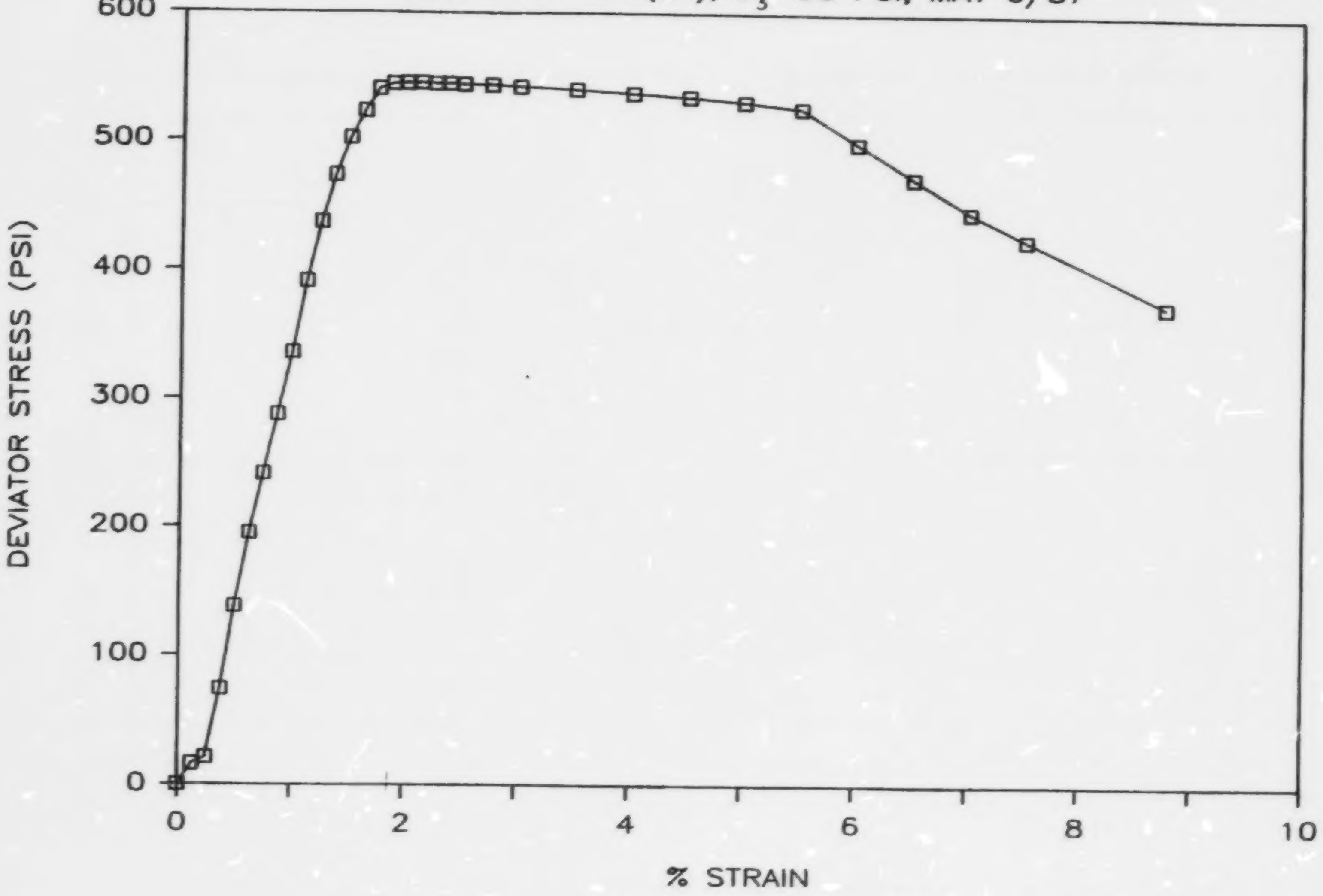
INCO-MINE BACKFILL, UU TEST #22

SAMPLE L-11A(4A), σ_3=25 PSI, MAY 6/87



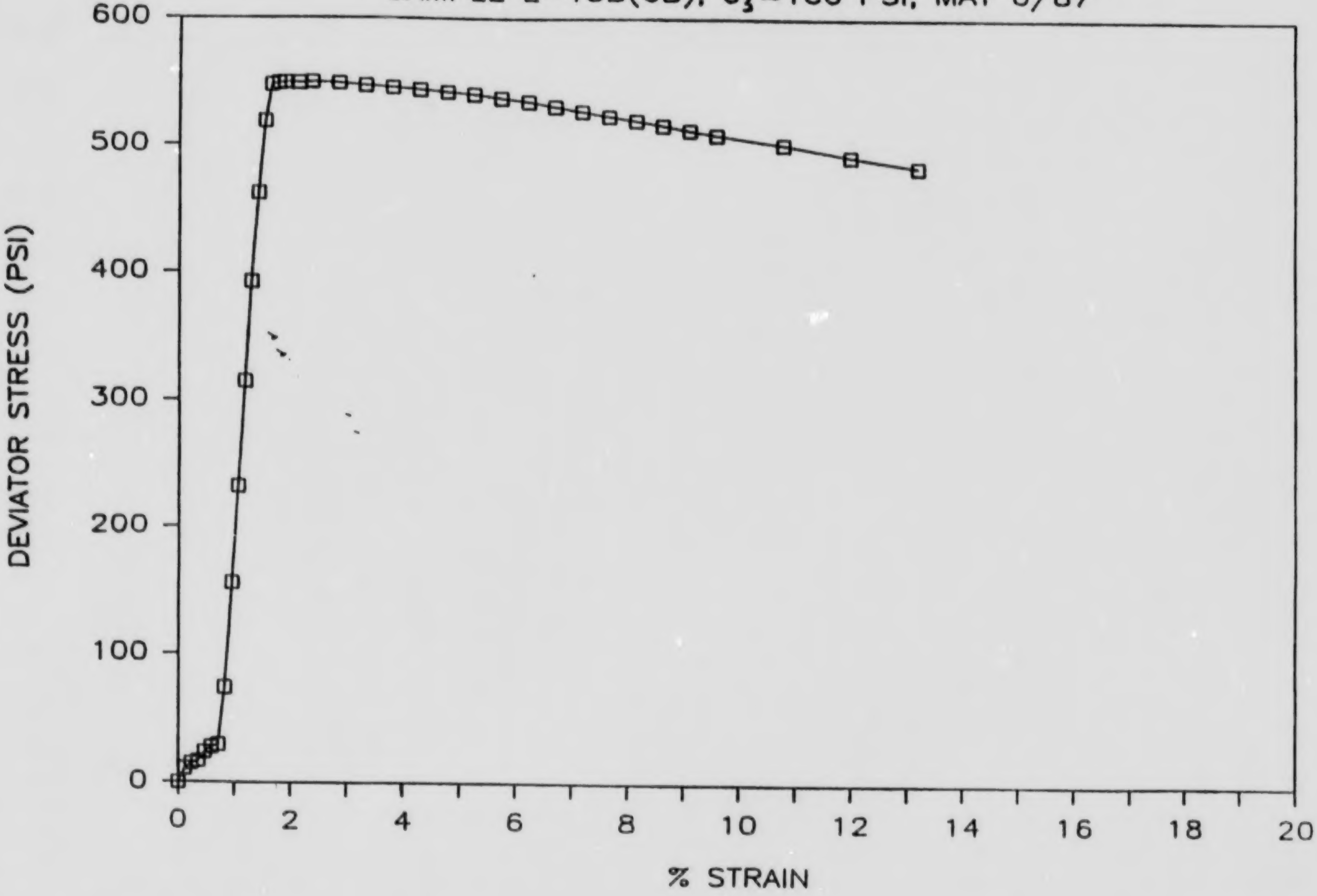
INCO—MINE BACKFILL, UU TEST #23

SAMPLE L—13A(6A), σ_3=50 PSI, MAY 6/87

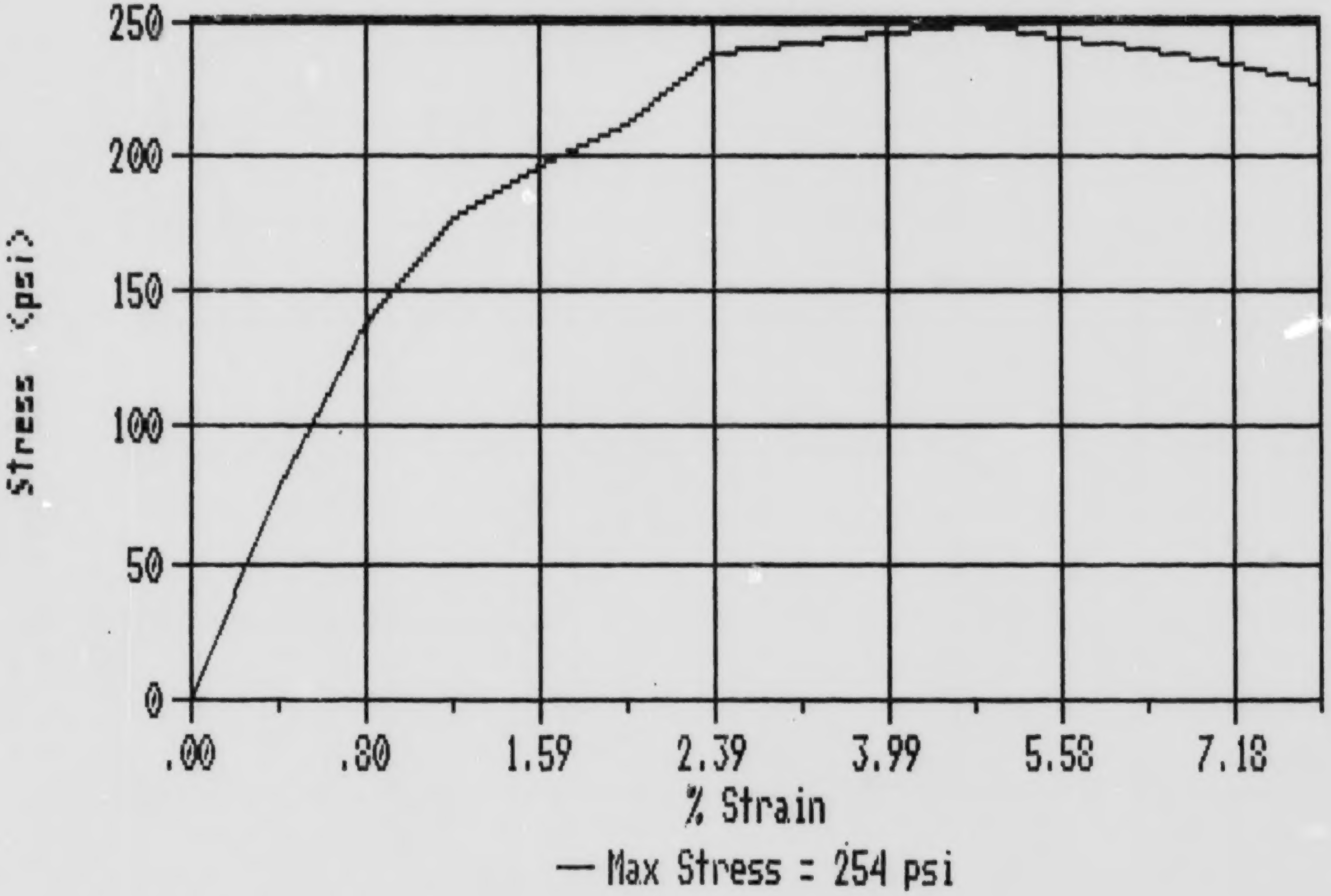


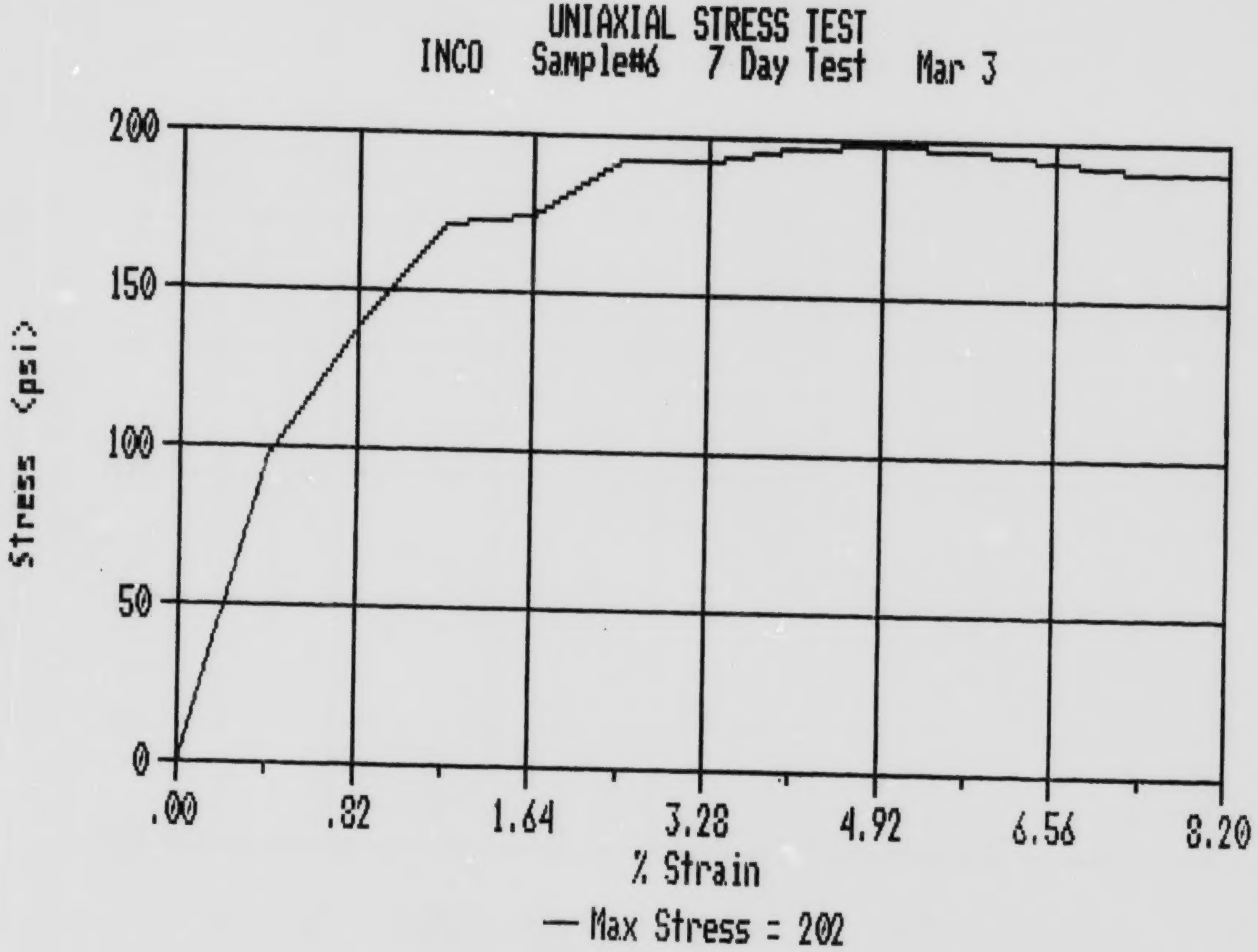
INCO–MINE BACKFILL, UU TEST #24

SAMPLE L–13B(6B), σ_3=100 PSI, MAY 6/87



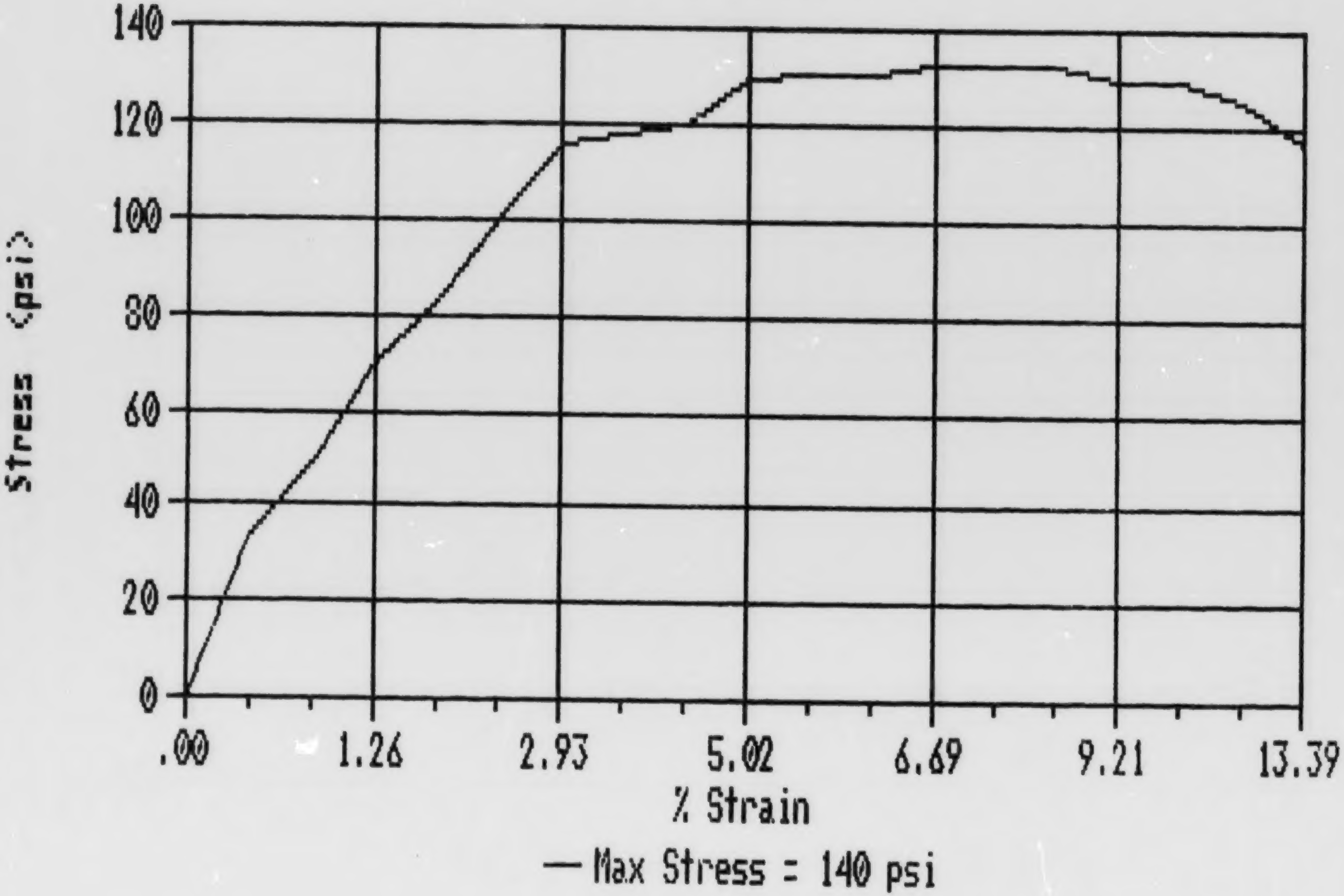
UNIAXIAL STRESS TEST
INCO Sample#2 7 Day Test Mar 3



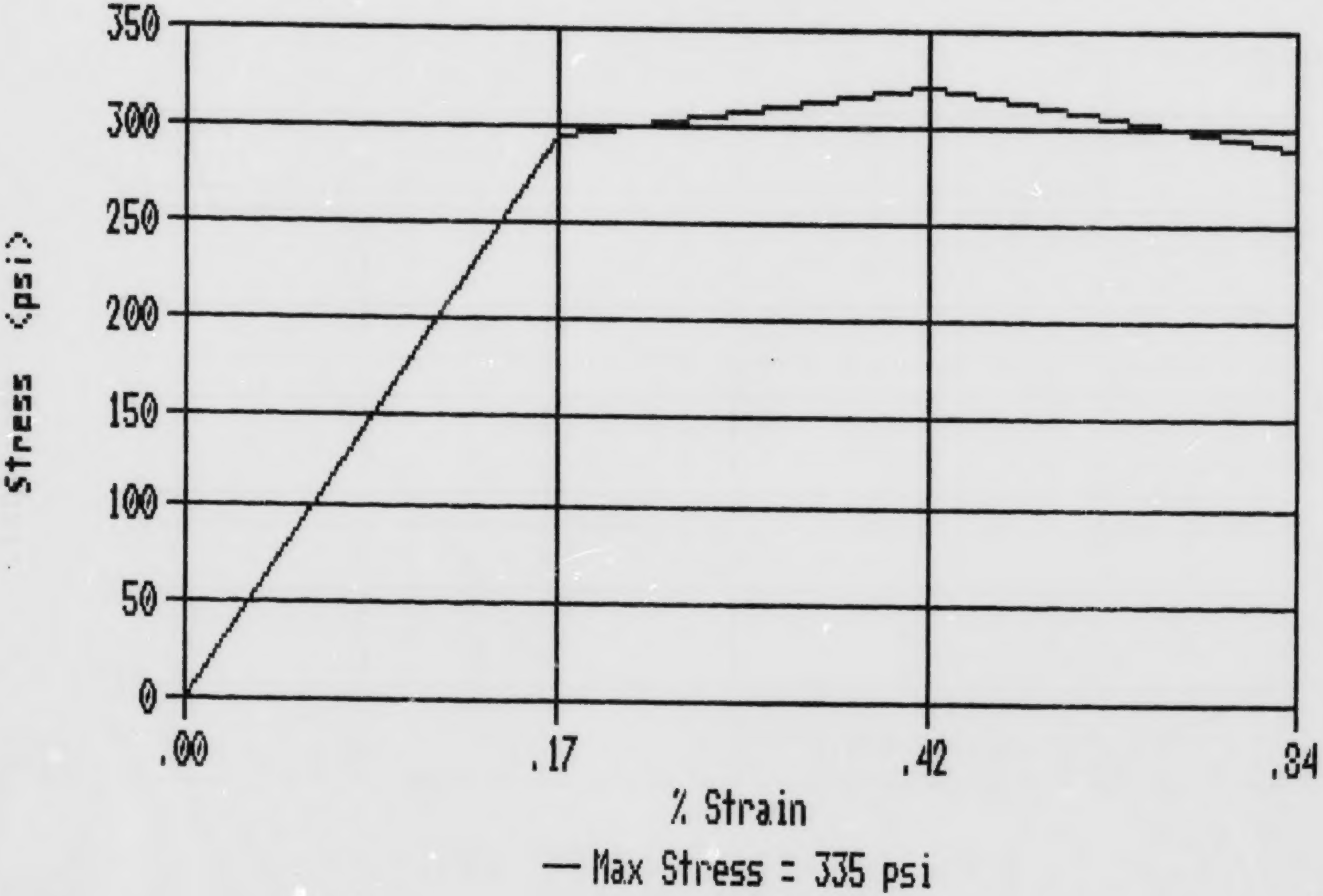


UNIAXIAL STRESS TEST
INCO Sample#6 7 Day Test Mar 3

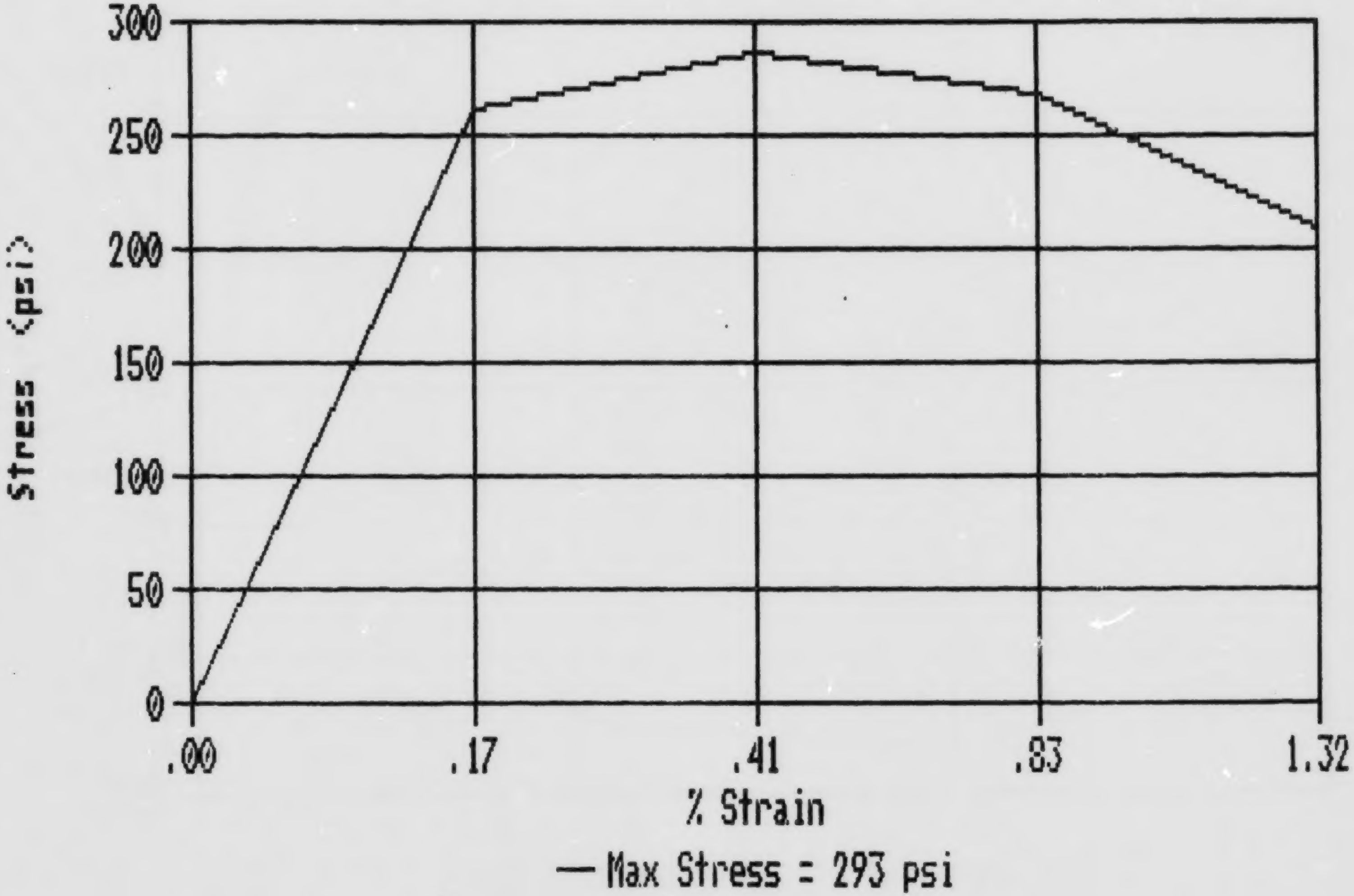
UNIAXIAL STRESS TEST
INCO Sample#10 7 Day Test Mar 3



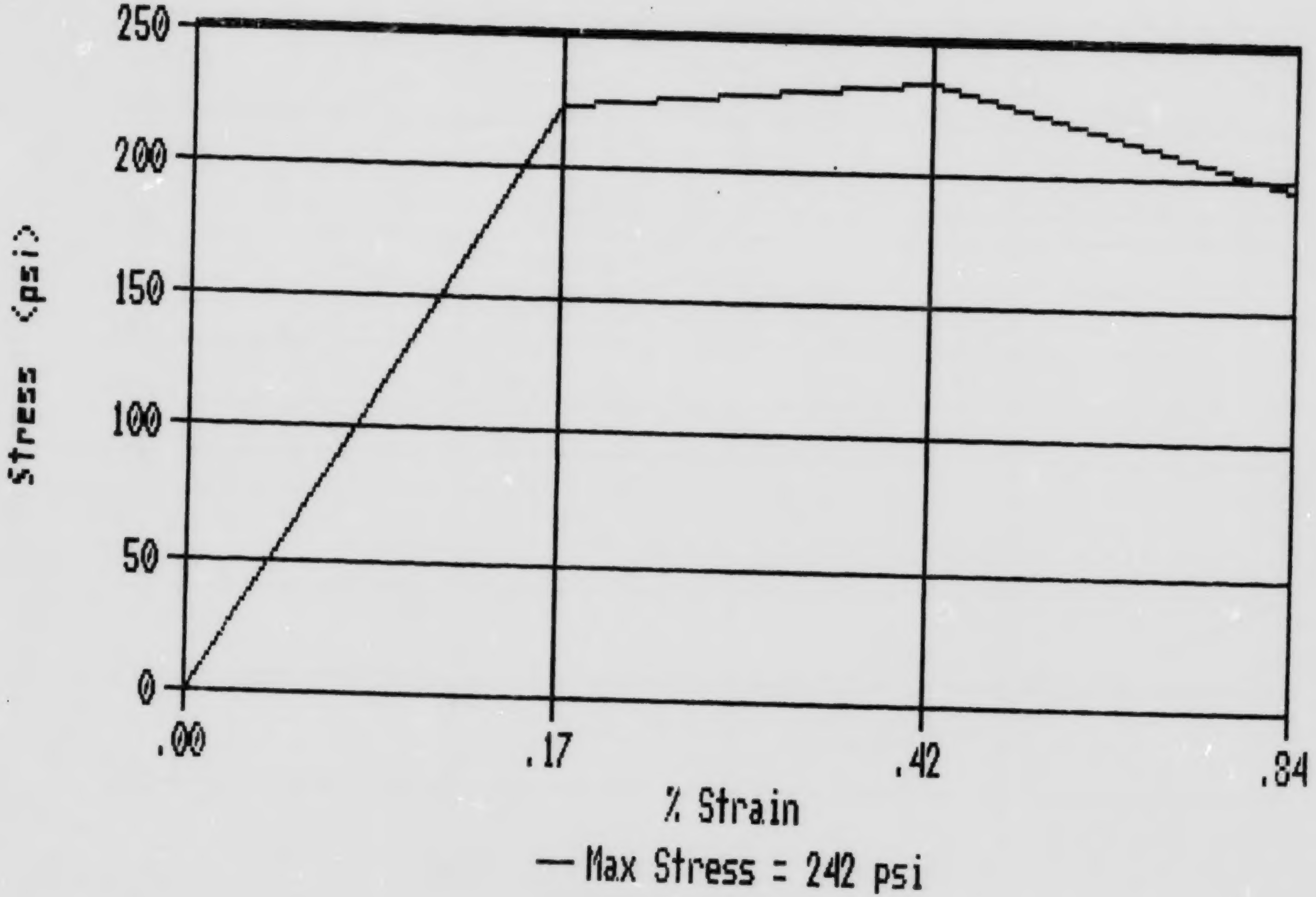
UNIAXIAL STRESS TEST
INCO Sample#4 28 Day Test Mar 24



UNIAXIAL STRESS TEST
INCO Sample#8 28 Day Test Mar 24

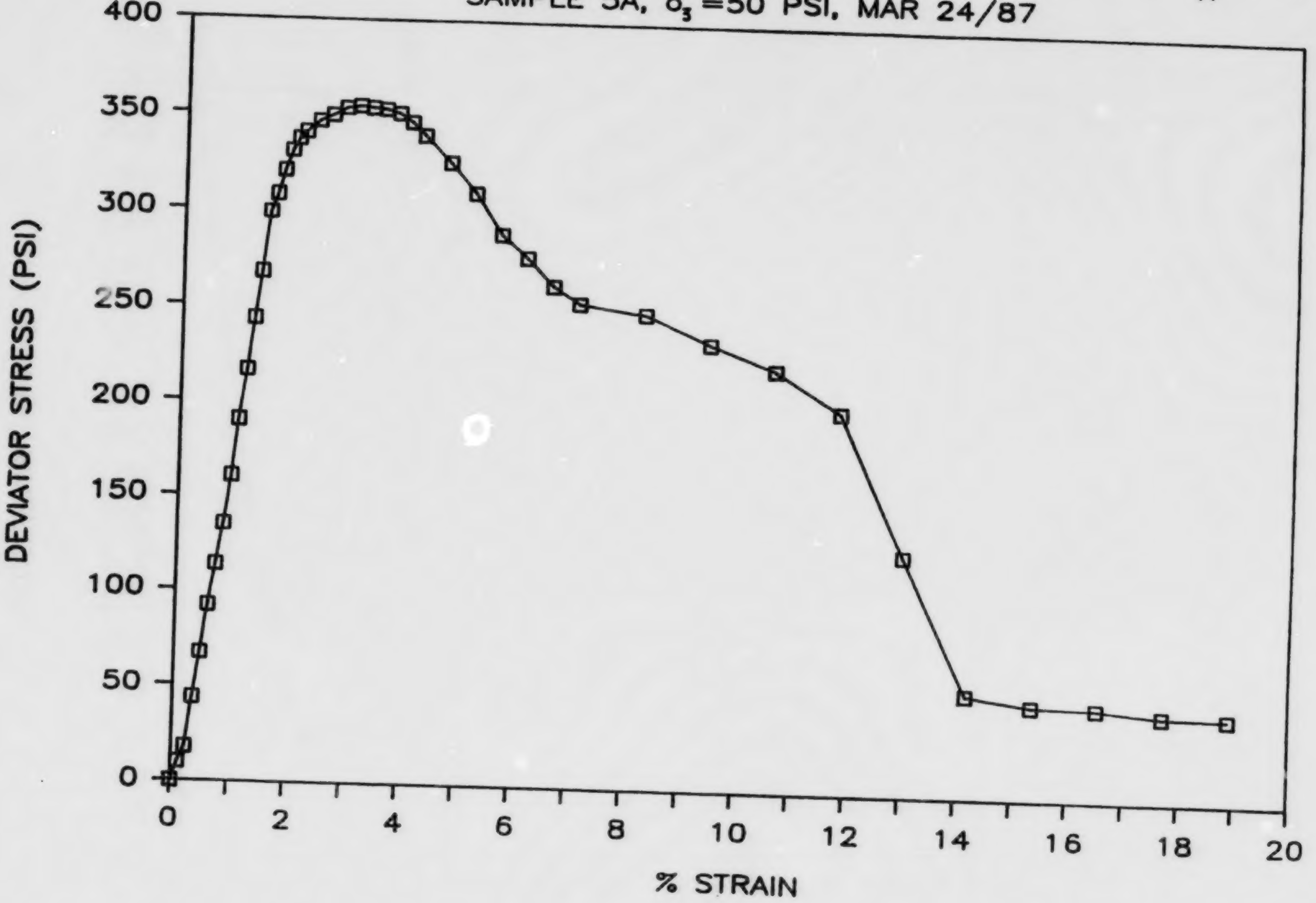


UNIAXIAL STRESS TEST
INCO Sample#12 28 Day Test Mar 24



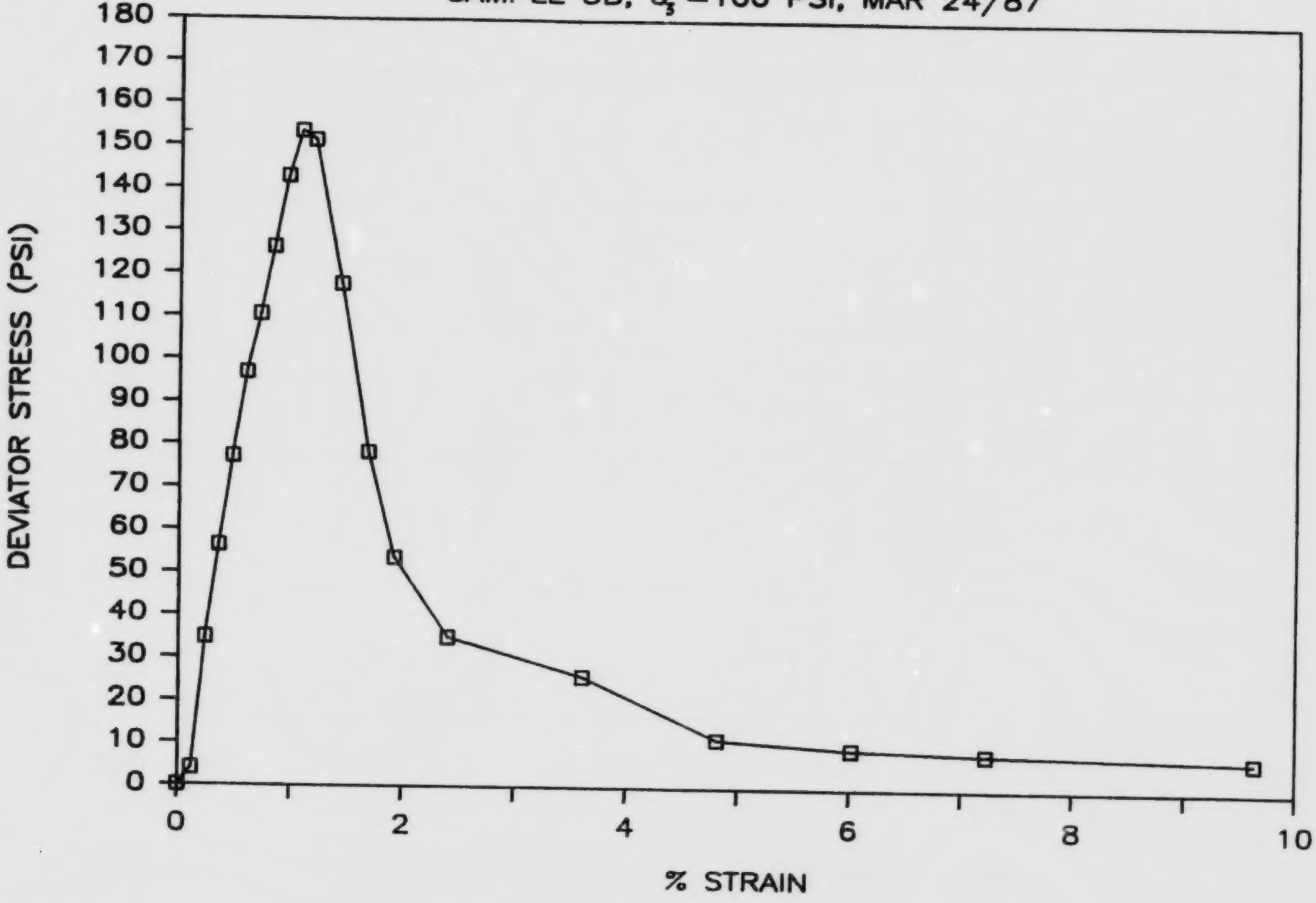
INCO–MINE BACKFILL, UU TEST #14

SAMPLE 5A, σ_3 =50 PSI, MAR 24/87



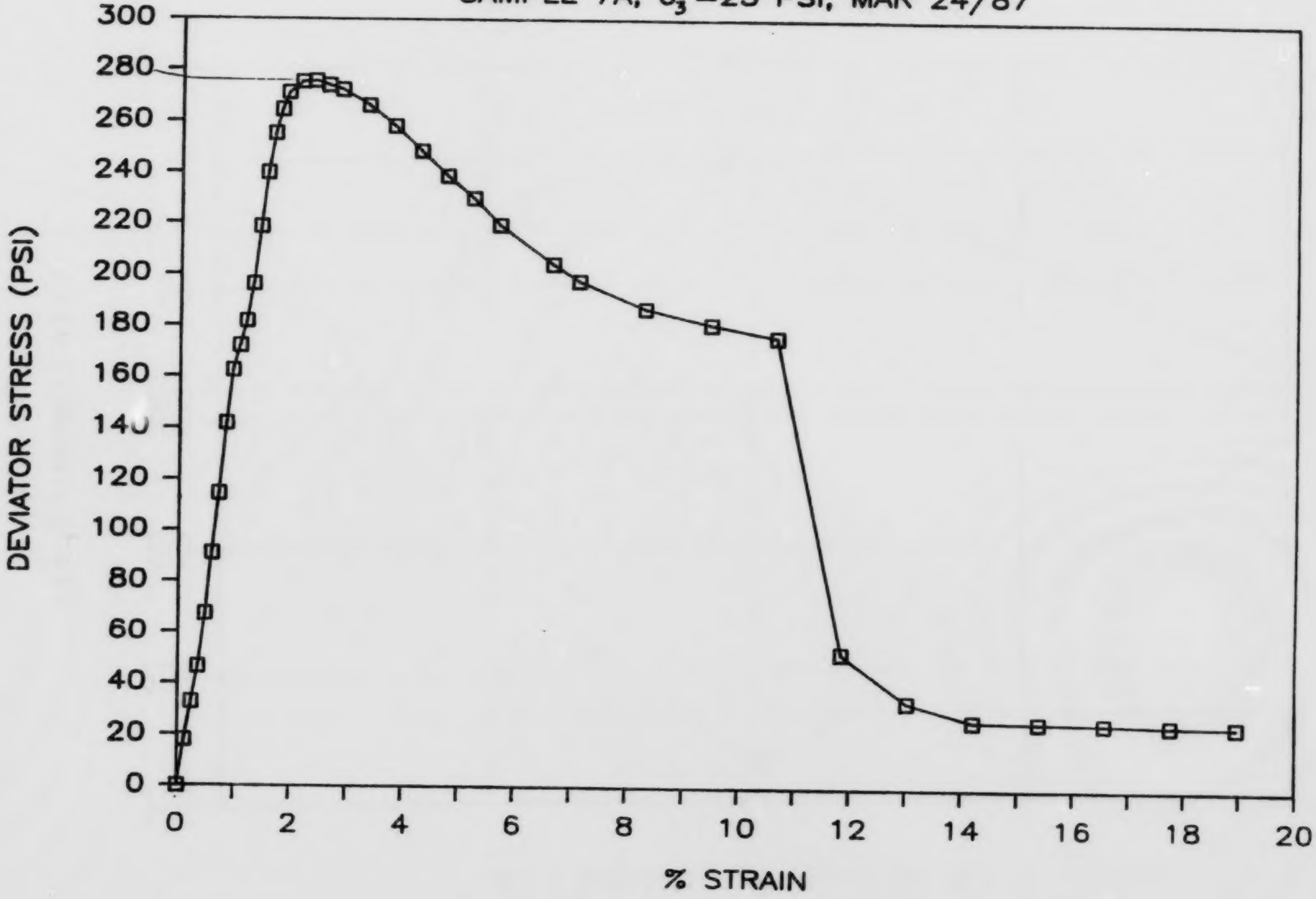
INCO—MINE BACKFILL, UU TEST #15

SAMPLE 5B, σ_3 =100 PSI, MAR 24/87

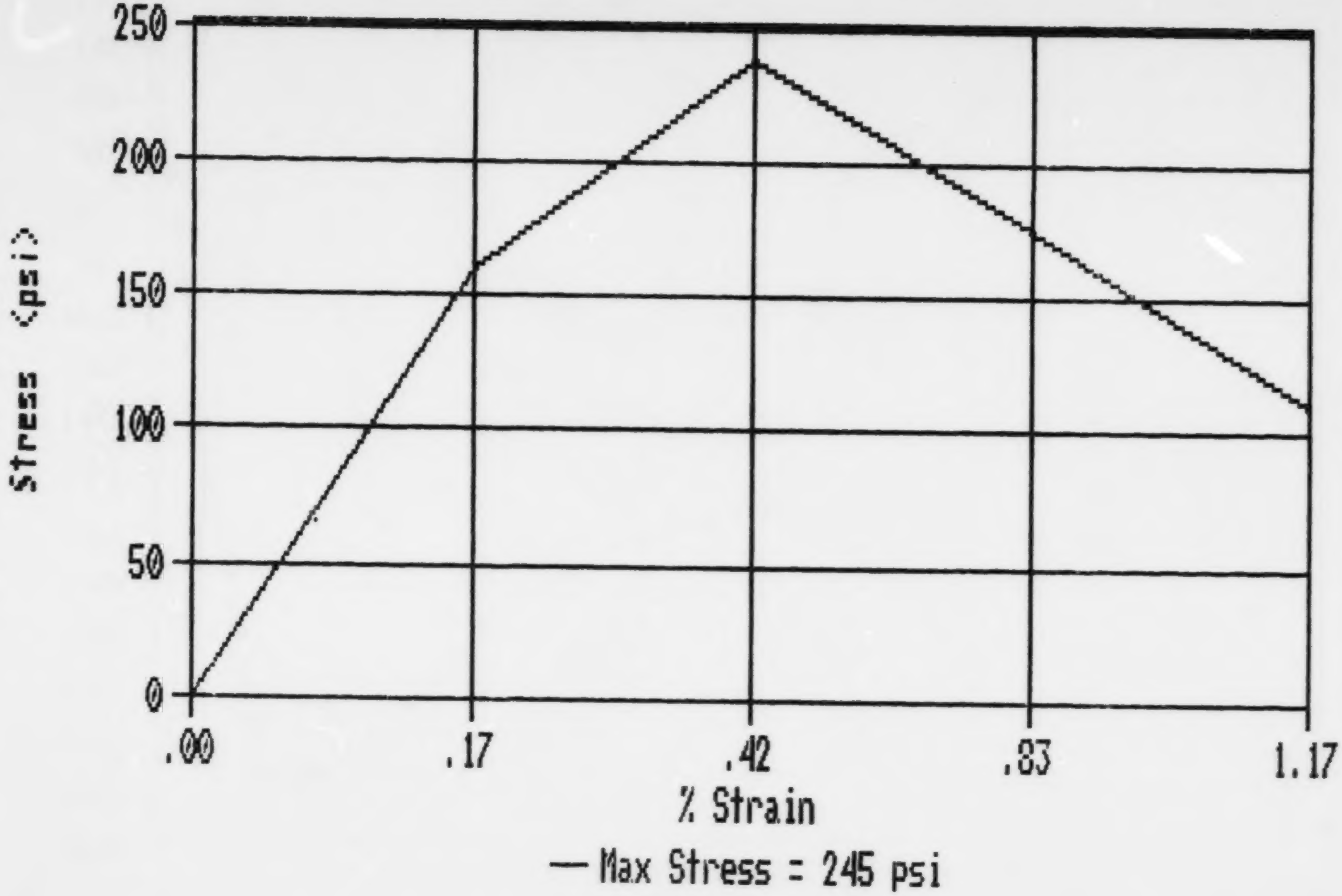


INCO—MINE BACKFILL, UU TEST #13

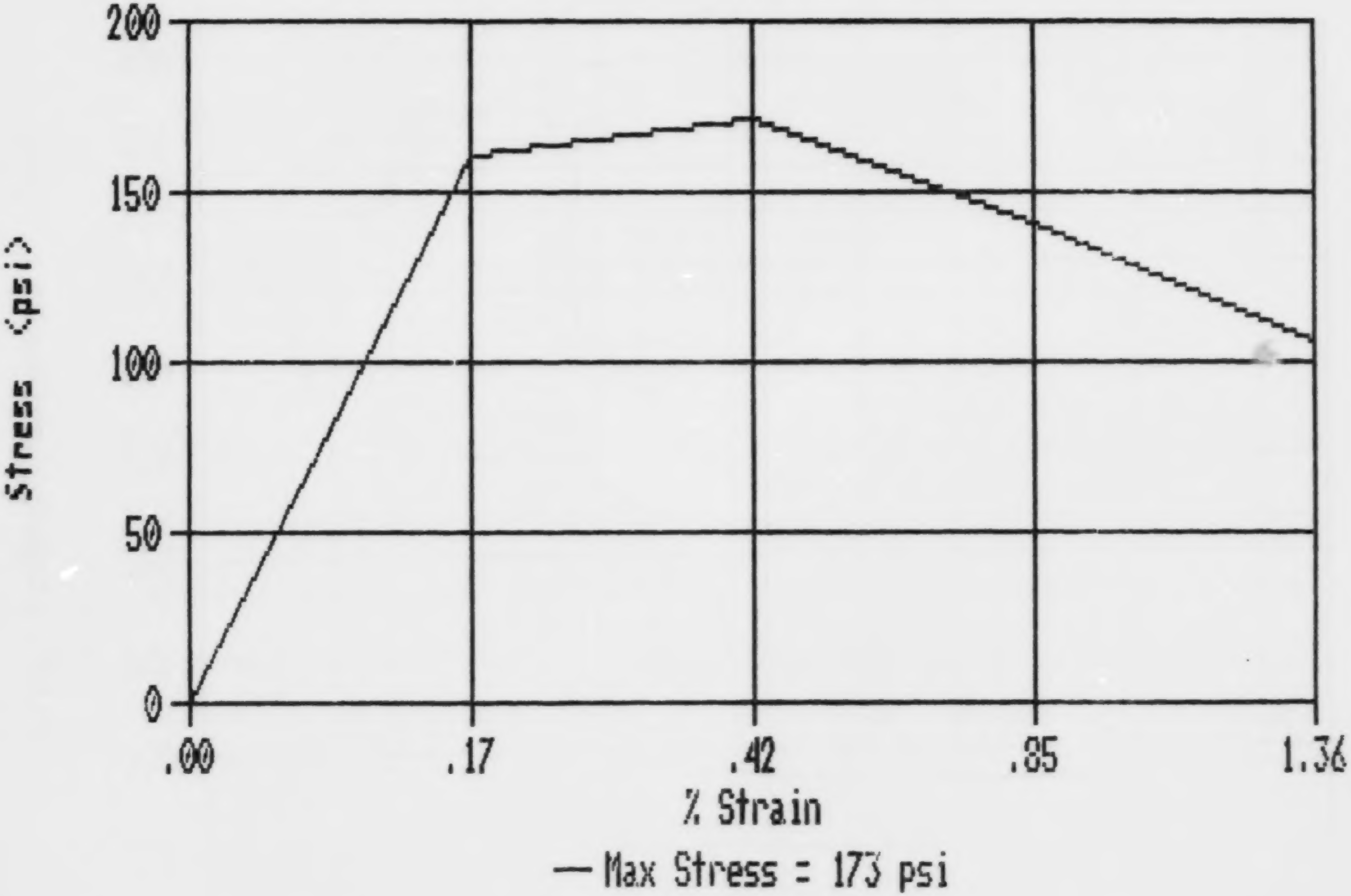
SAMPLE 7A, σ_3=25 PSI, MAR 24/87



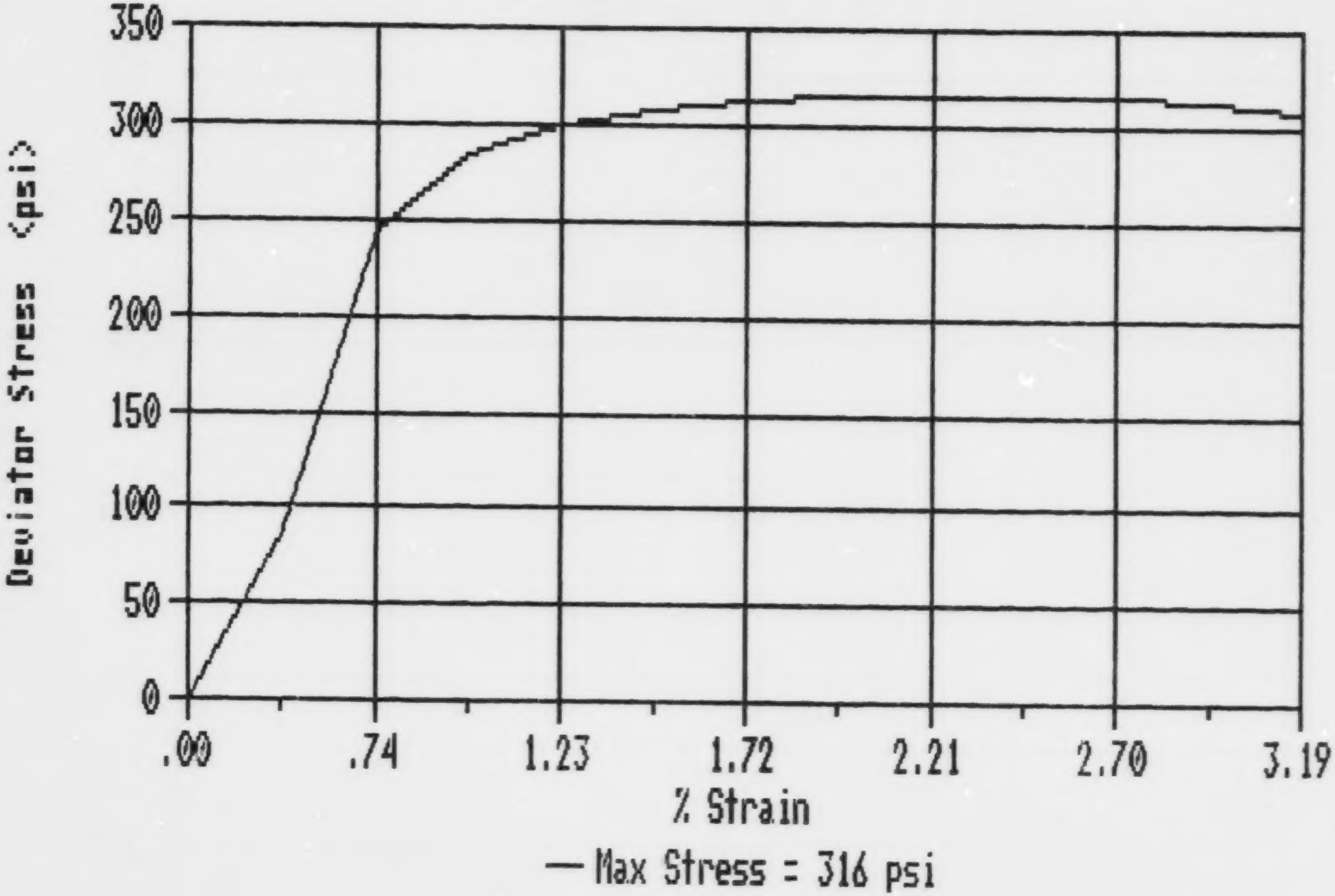
UNIAXIAL STRESS TEST
INCO Sample#13 7 Day Test Mar 5



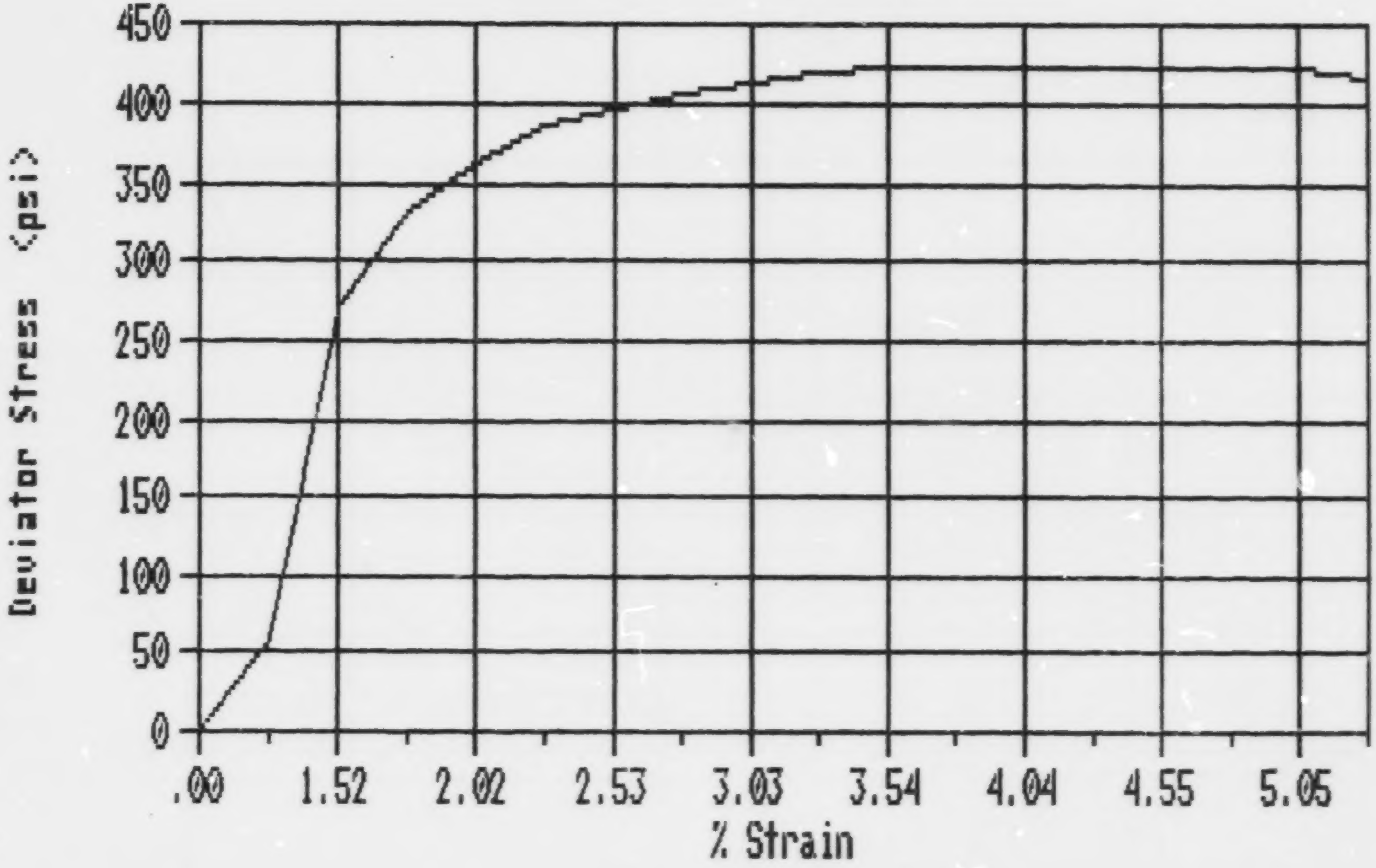
UNIAXIAL STRESS TEST
INCO Sample#15 7 Day Test Mar 5



TRIAXIAL STRESS TEST
INCO #14 Sig3= 25psi 7 Days Mar 5

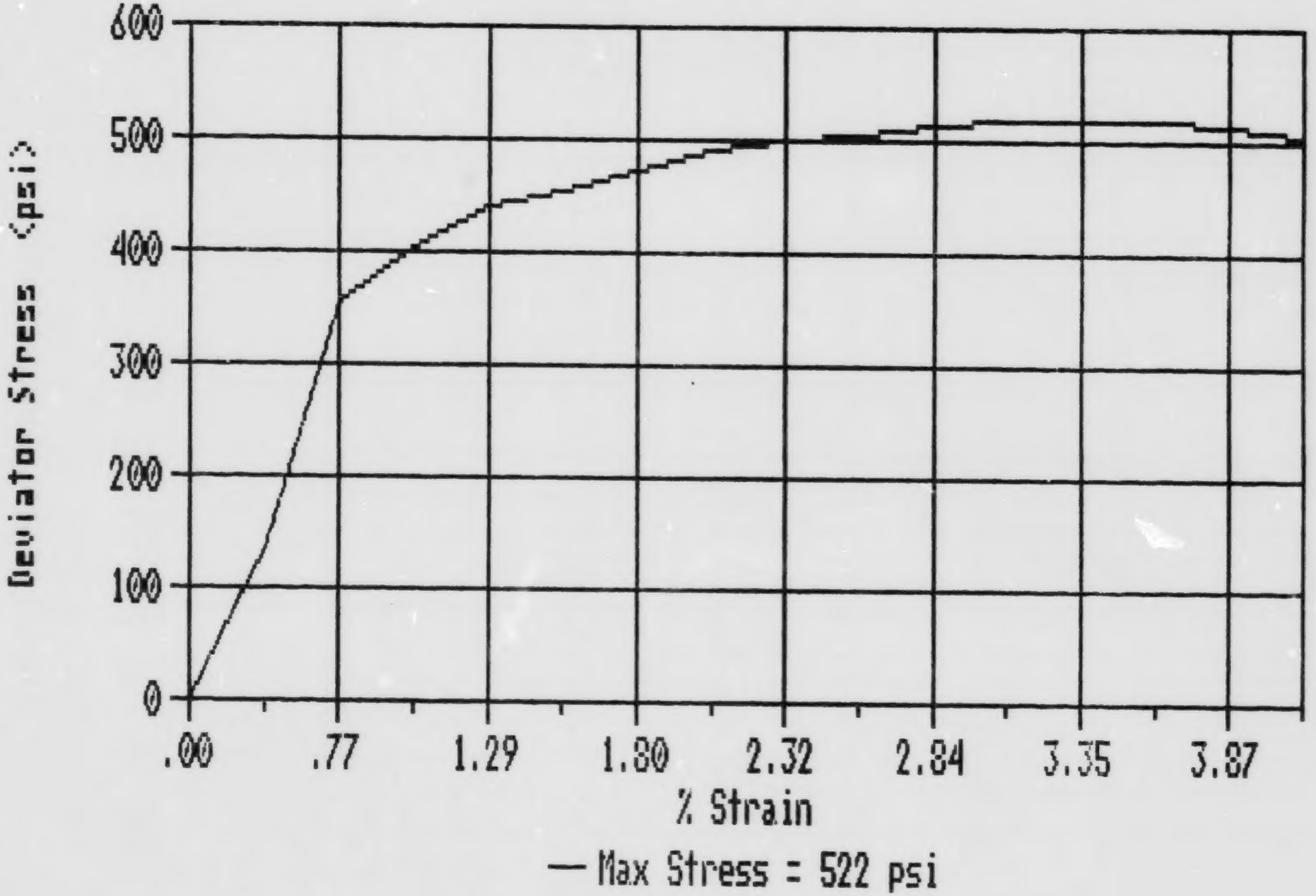


TRIAXIAL STRESS TEST
INCO #16 Sig3= 50 psi 7 Days Mar 5

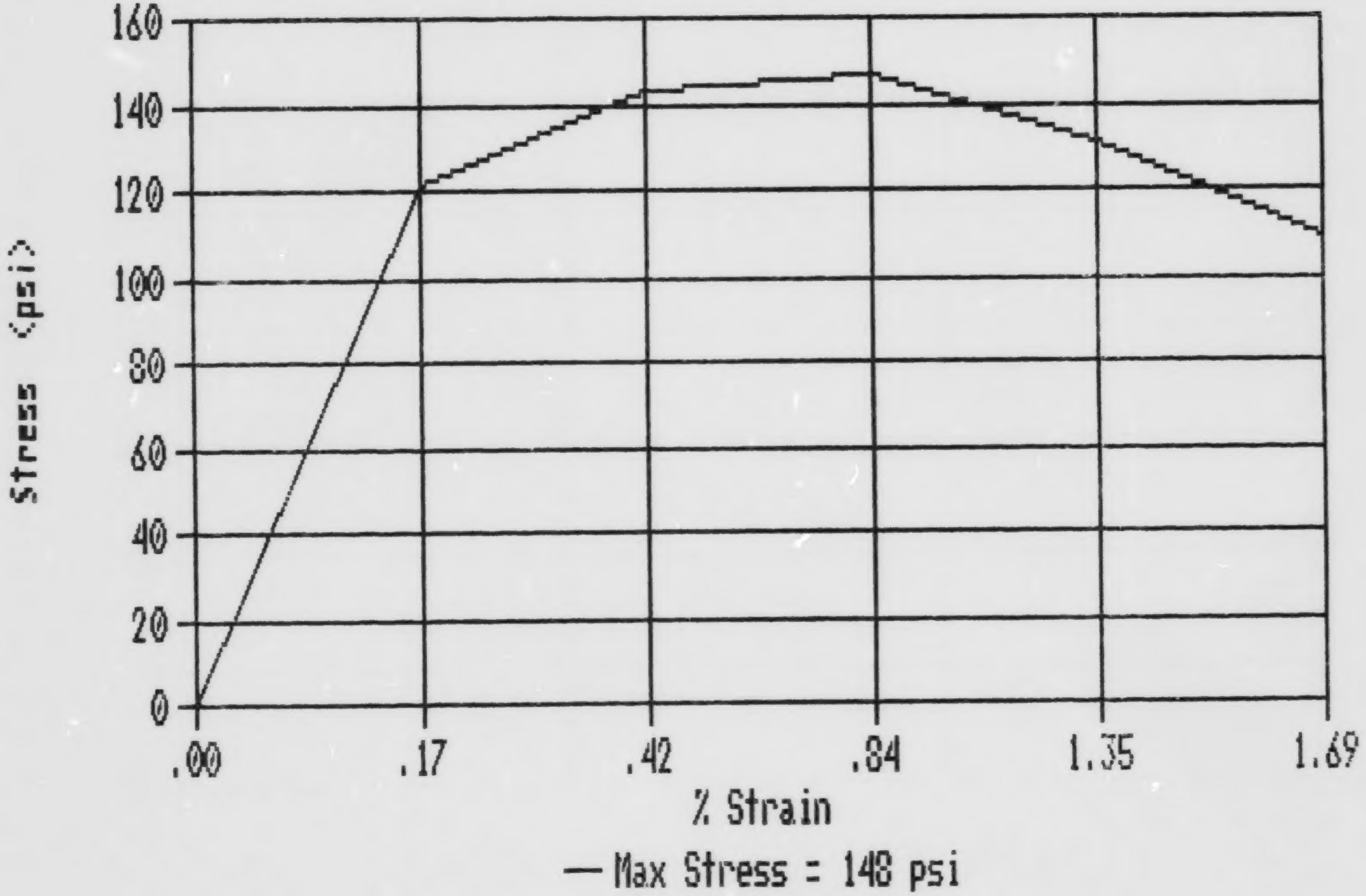


— Max Stress = 425 psi

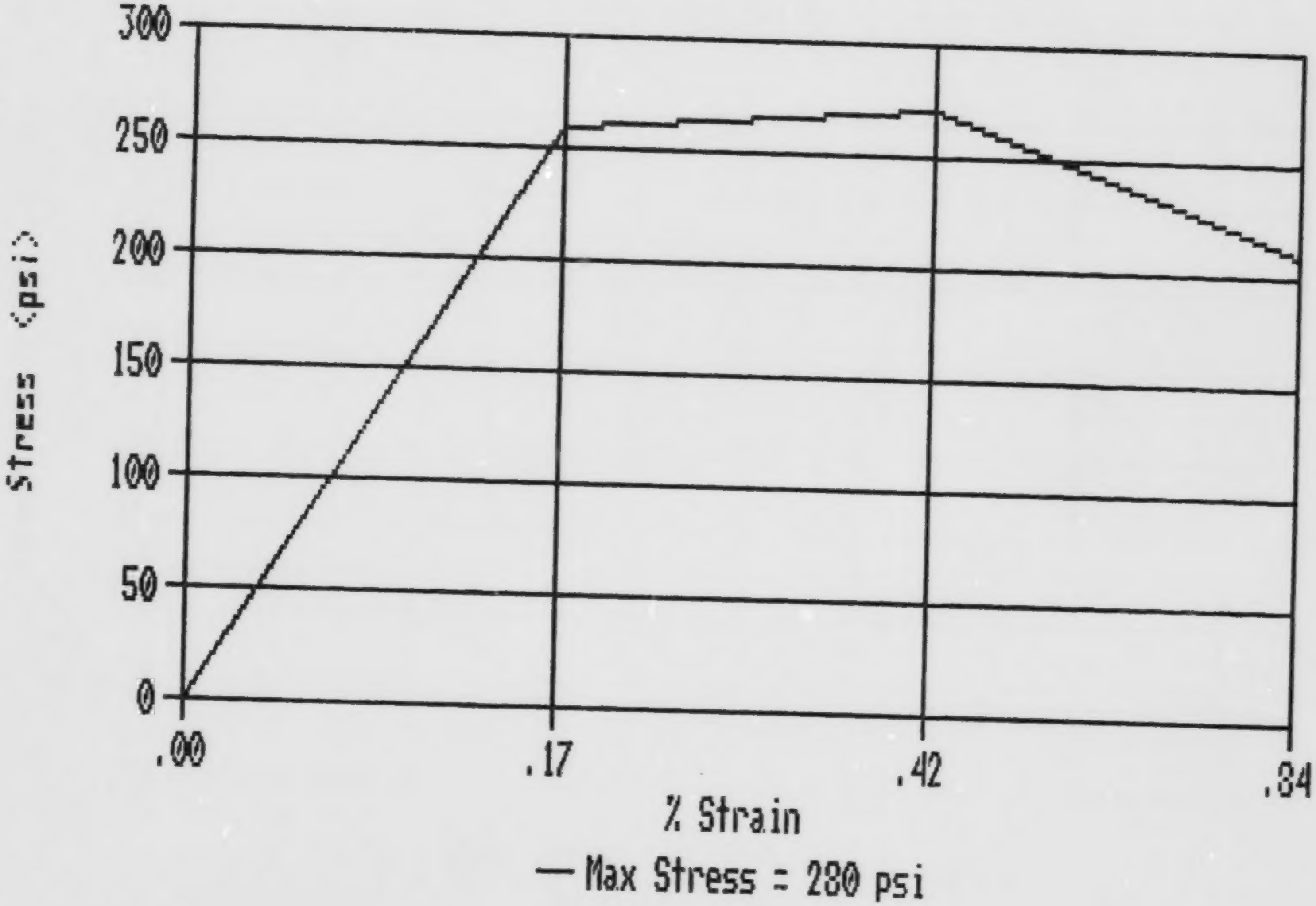
TRIAXIAL STRESS TEST
INCO #16A Sig3= 100psi 7 Days Mar 5



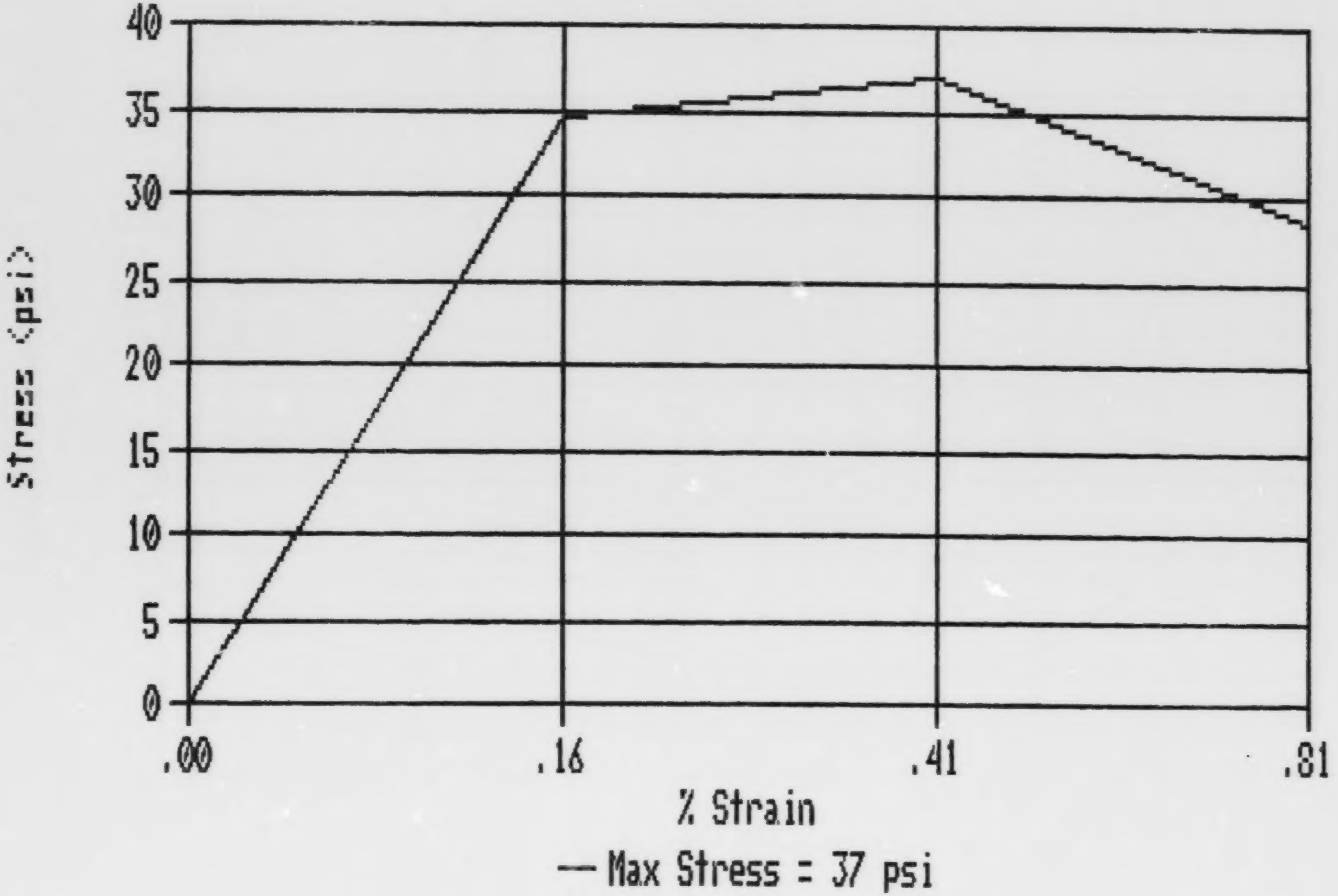
UNIAXIAL STRESS TEST
INCO Sample#17 7 Day Test Mar 9



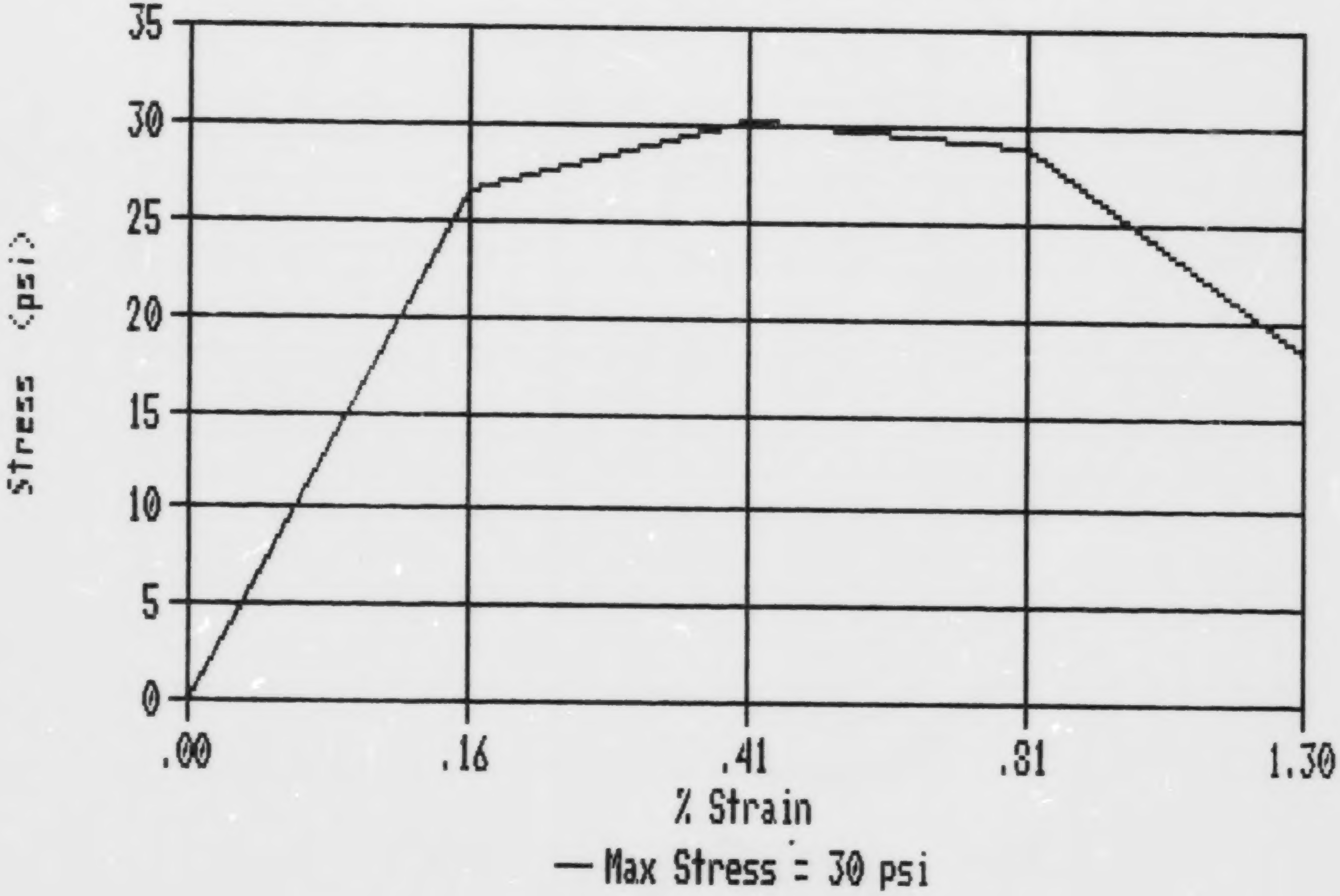
UNIAXIAL STRESS TEST
INCO Sample#19 7 Day Test Mar 9



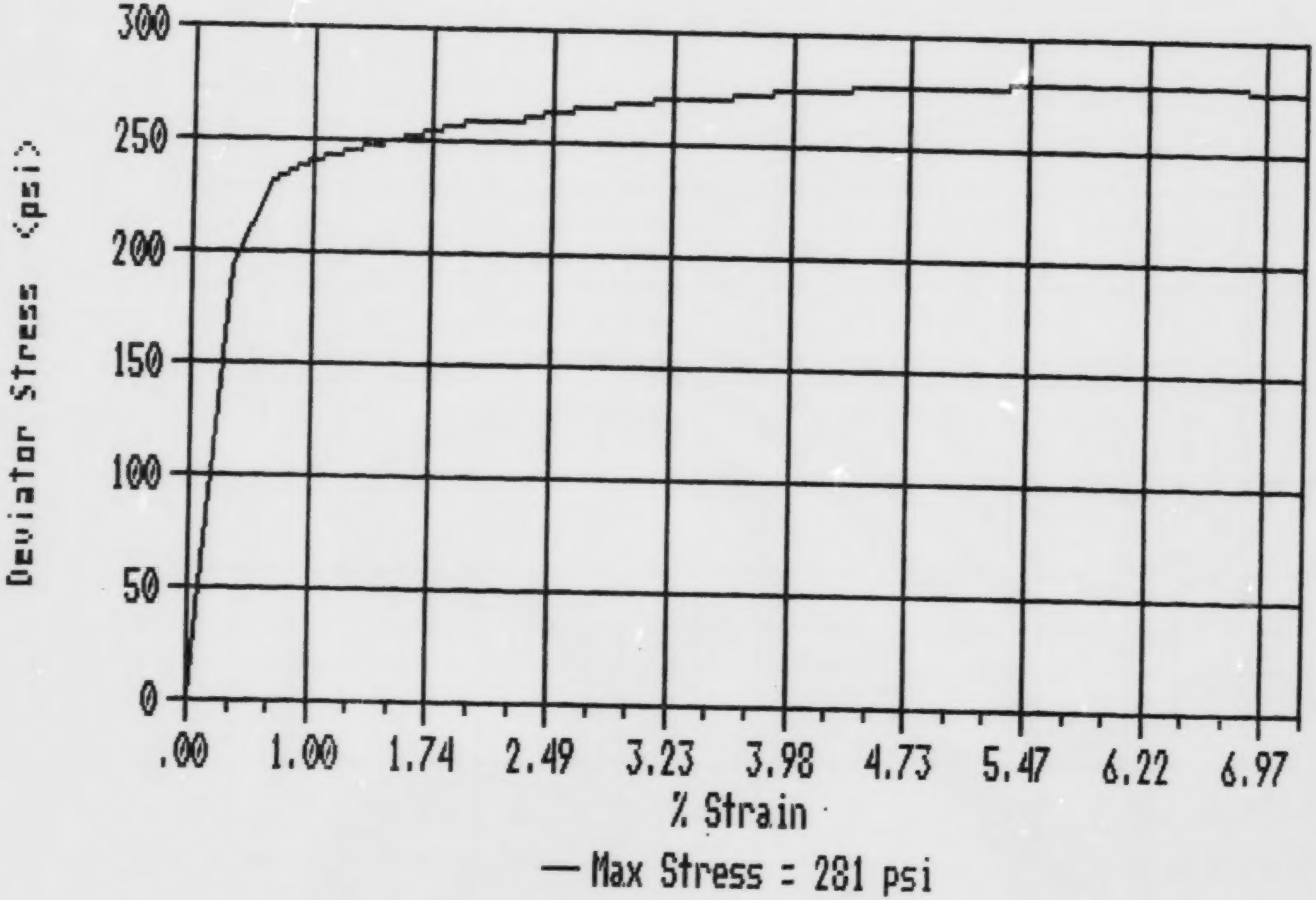
UNIAXIAL STRESS TEST
INCO Sample#21 28 Day Test Mar 30



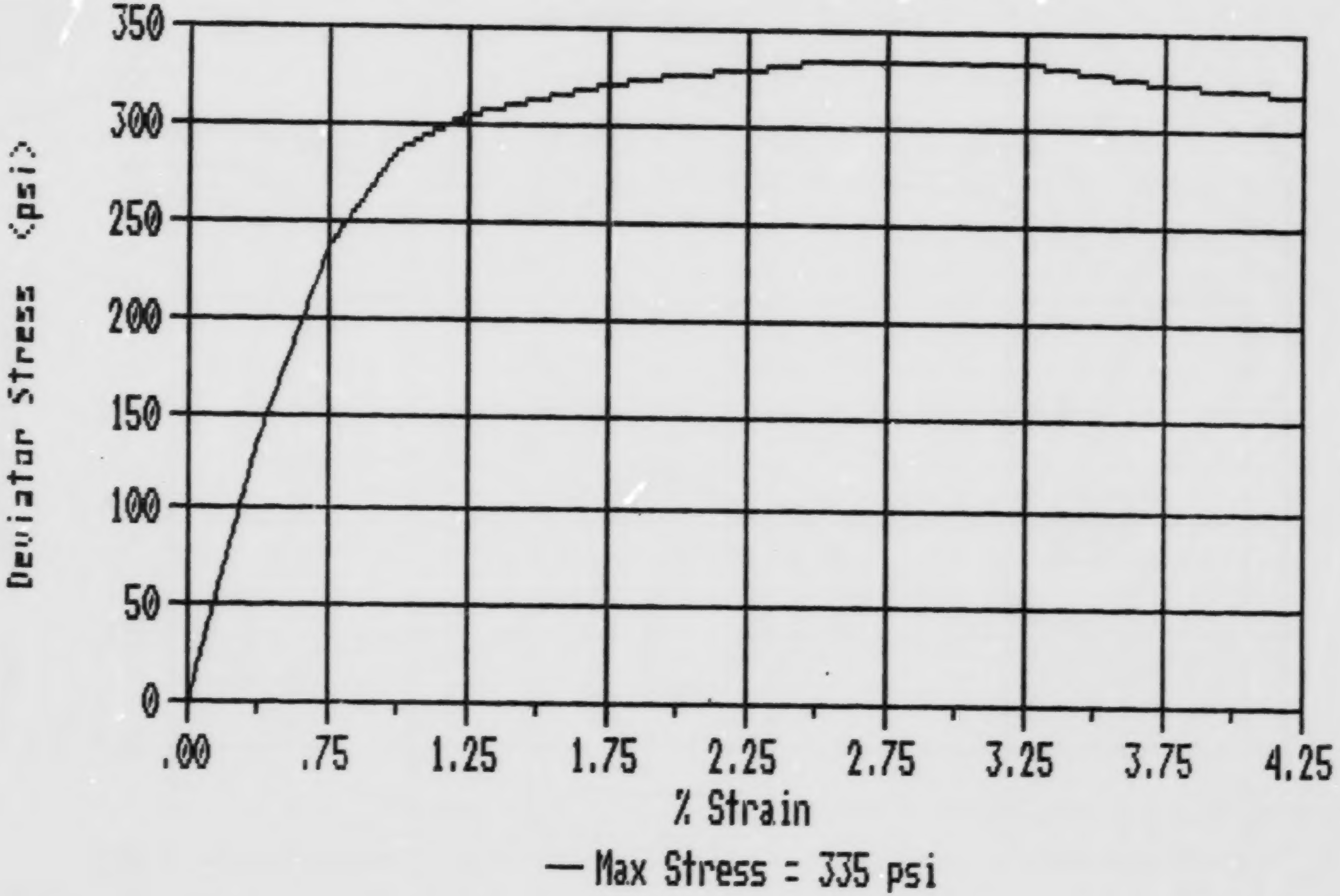
UNIAXIAL STRESS TEST
INCO Sample#23 28 Day Test Mar 30



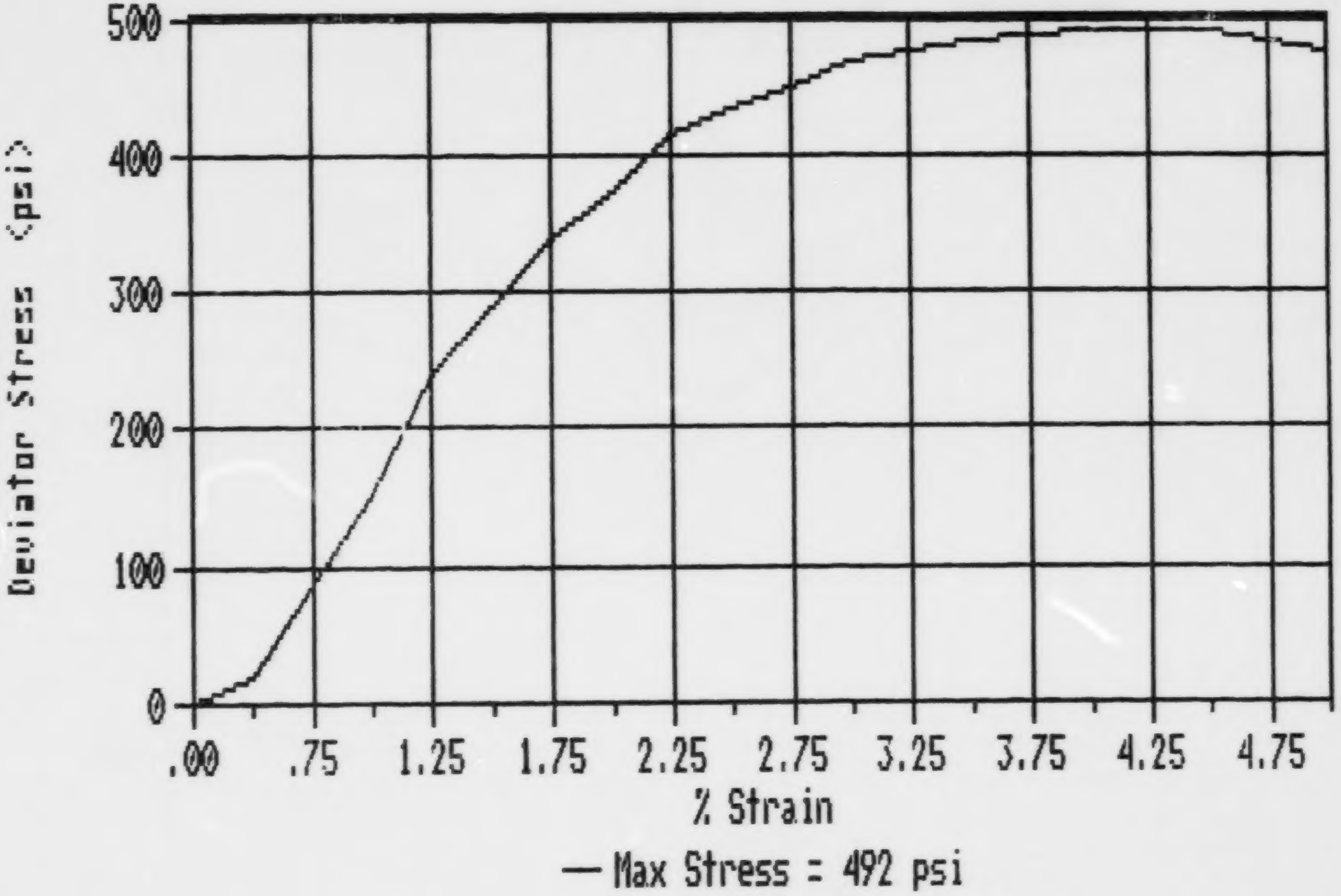
TRIAXIAL STRESS TEST
INCO #18 Sig3= 25 psi 7 Days Mar 9



TRIAXIAL STRESS TEST
INCO #20 Sig3= 50 psi 7 Days Mar 9

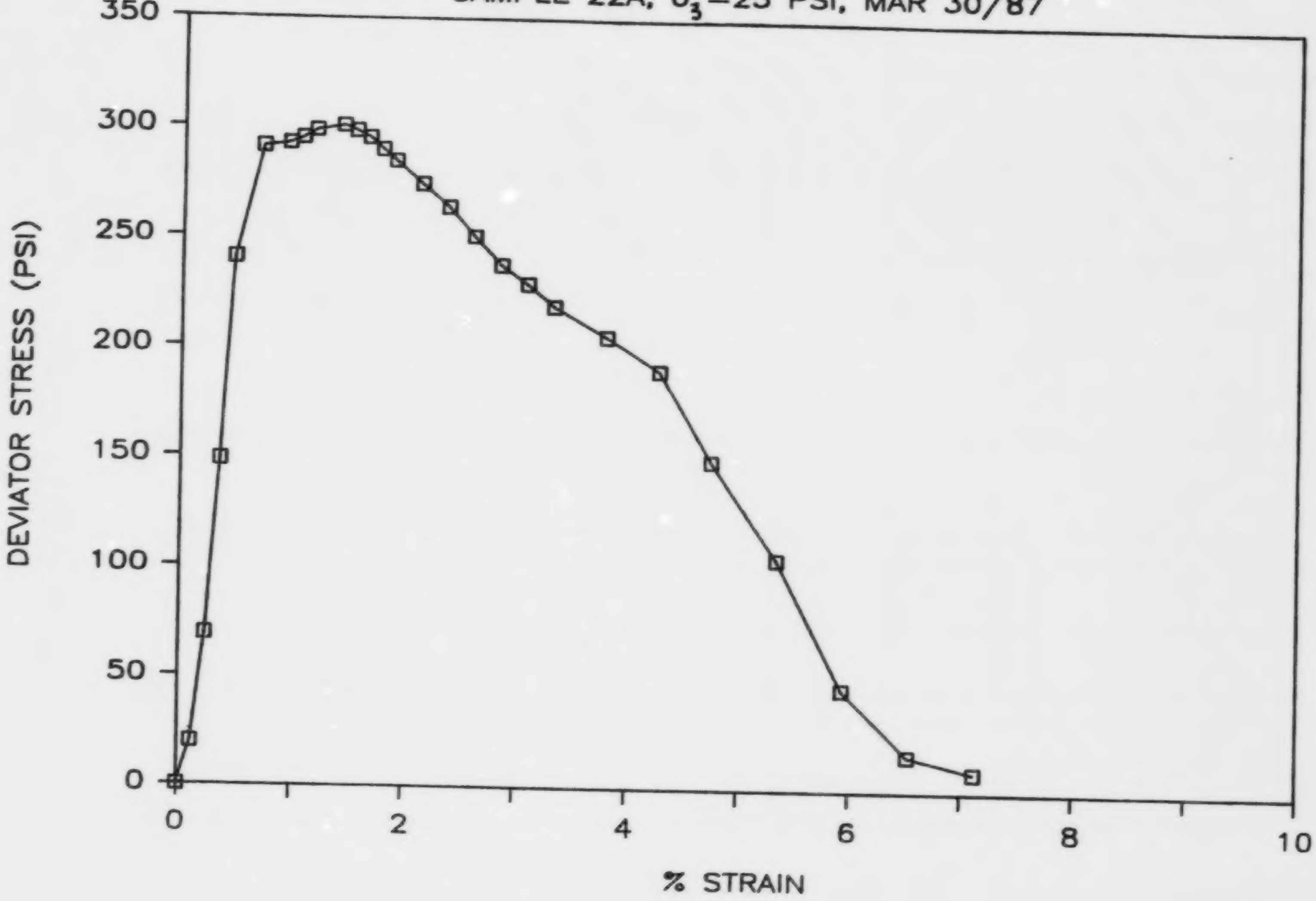


TRIAXIAL STRESS TEST
INCO #20A Sig3= 100 psi 7 Days Mar 9% Strain



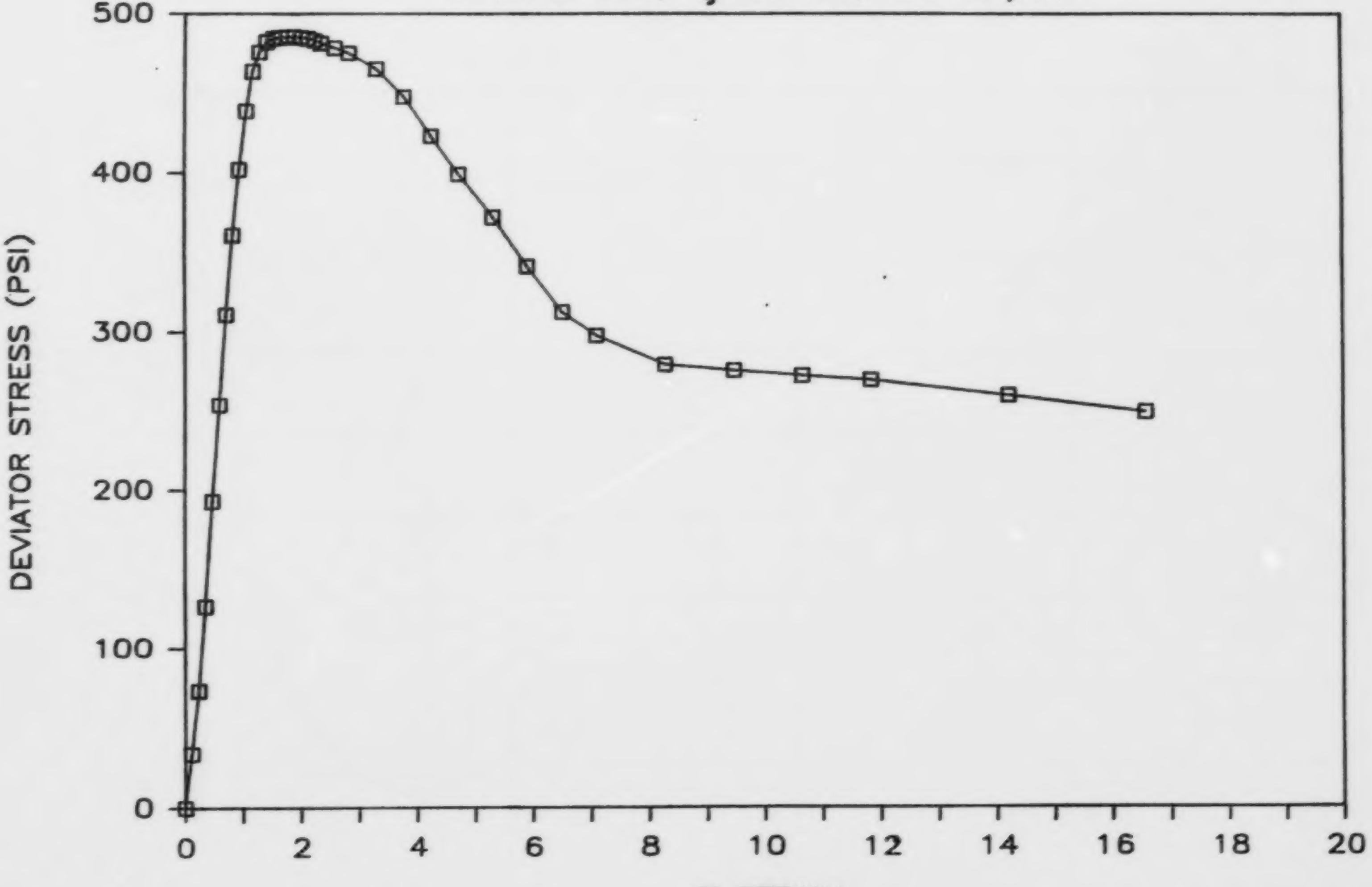
INCO—MINE BACKFILL, UU TEST #16

SAMPLE 22A, σ_3=25 PSI, MAR 30/87



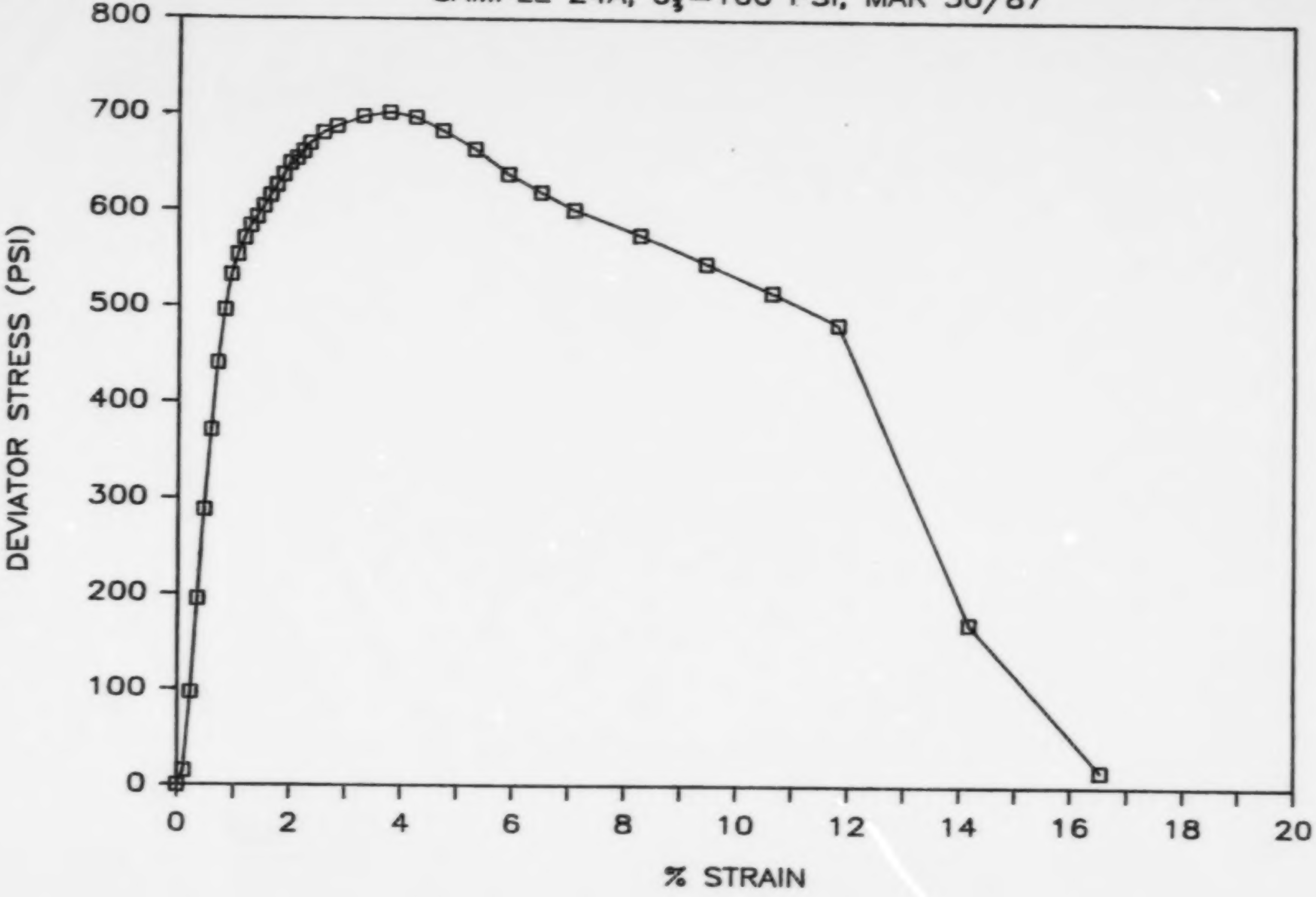
INCO—MINE BACKFILL, UU TEST #17

SAMPLE 22B, σ_3=50 PSI, MAR 30/87

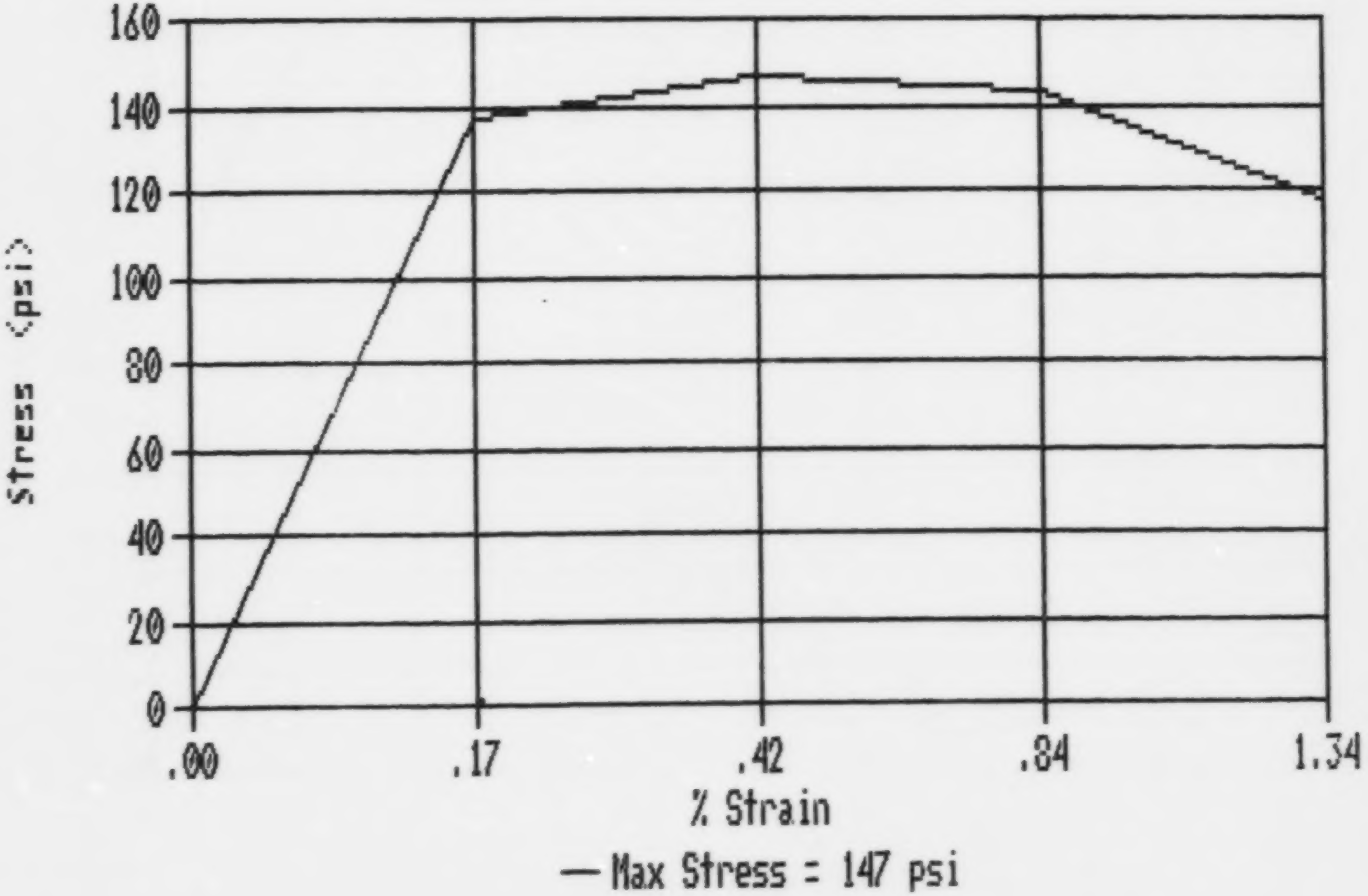


INCO—MINE BACKFILL, UU TEST #18

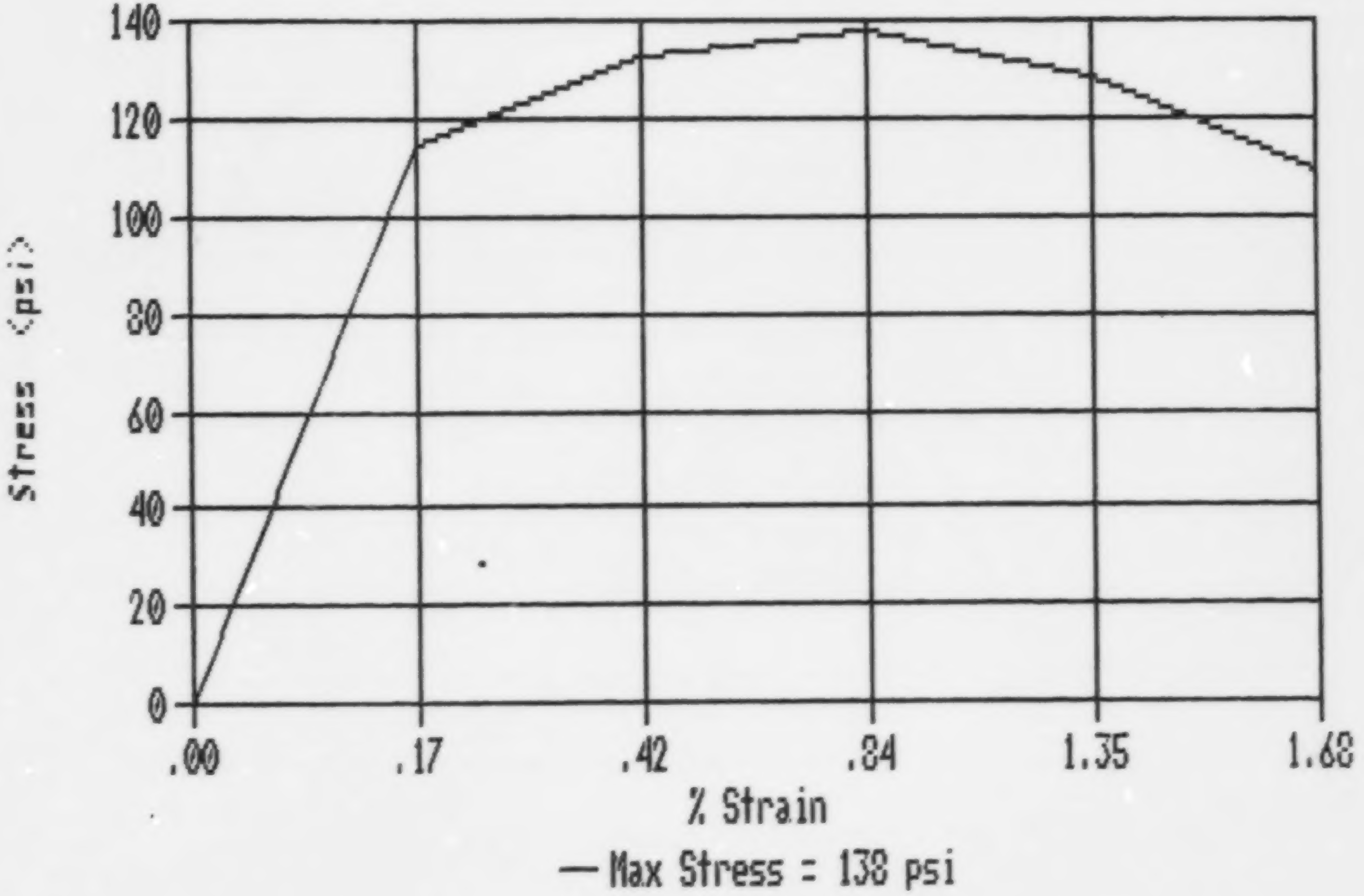
SAMPLE 24A, σ_3=100 PSI, MAR 30/87



UNIAXIAL STRESS TEST
INCO Sample#1 7 Day Test Mar 10

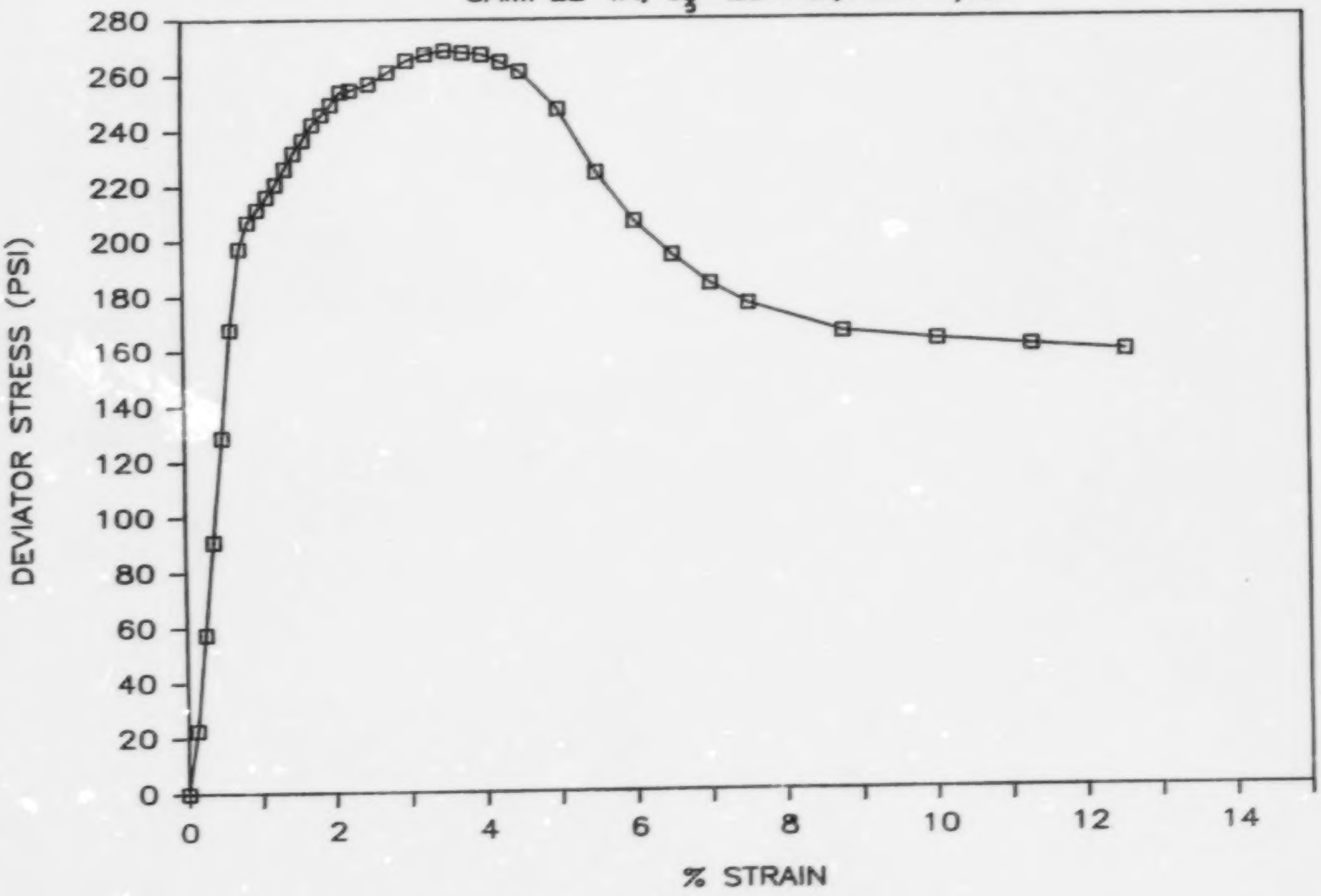


UNIAXIAL STRESS TEST
INCO Sample#3 7 Day Test Mar 10



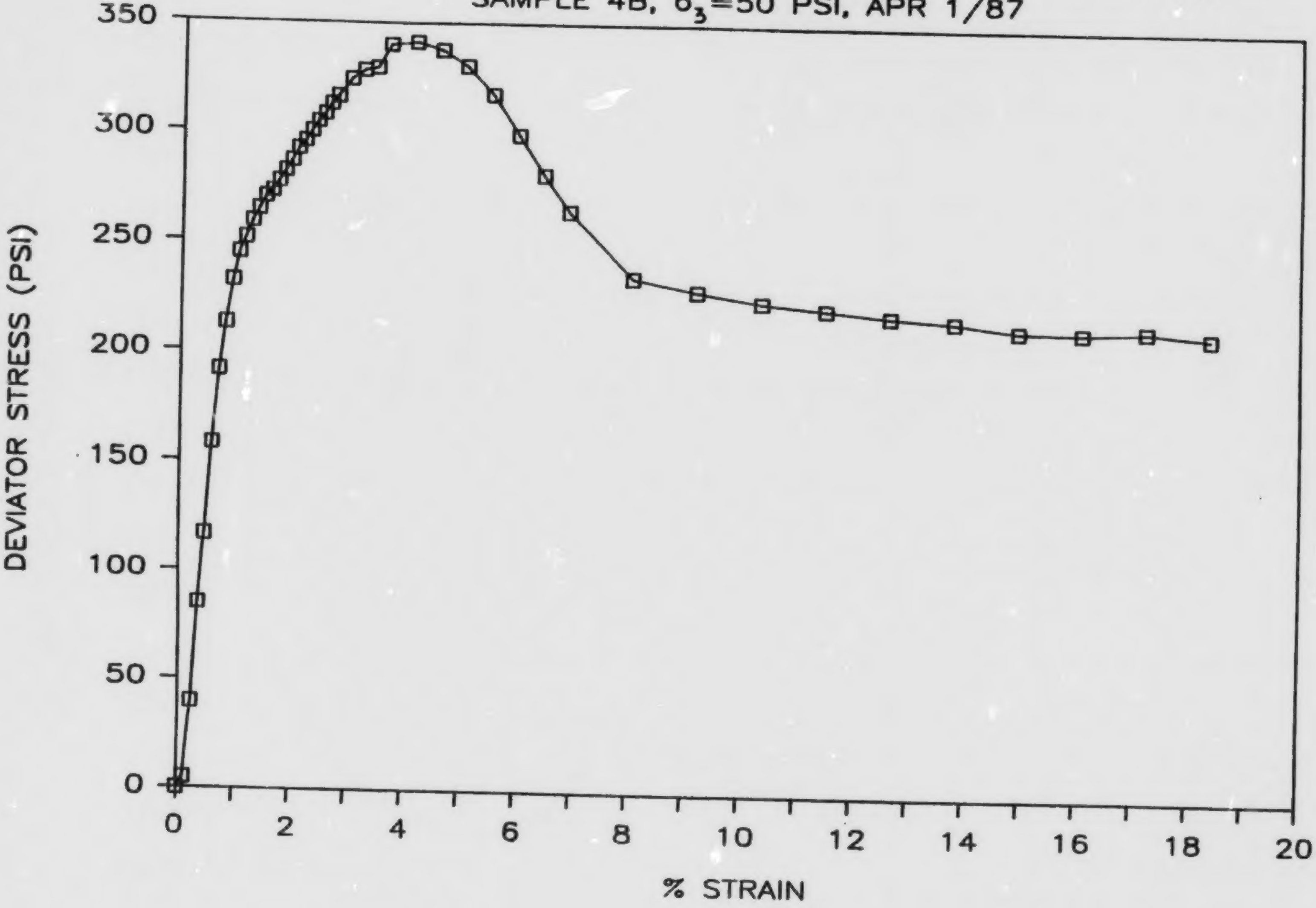
INCO—MINE BACKFILL, UU TEST #19

SAMPLE 4A, σ_3=25 PSI, APR 1/87



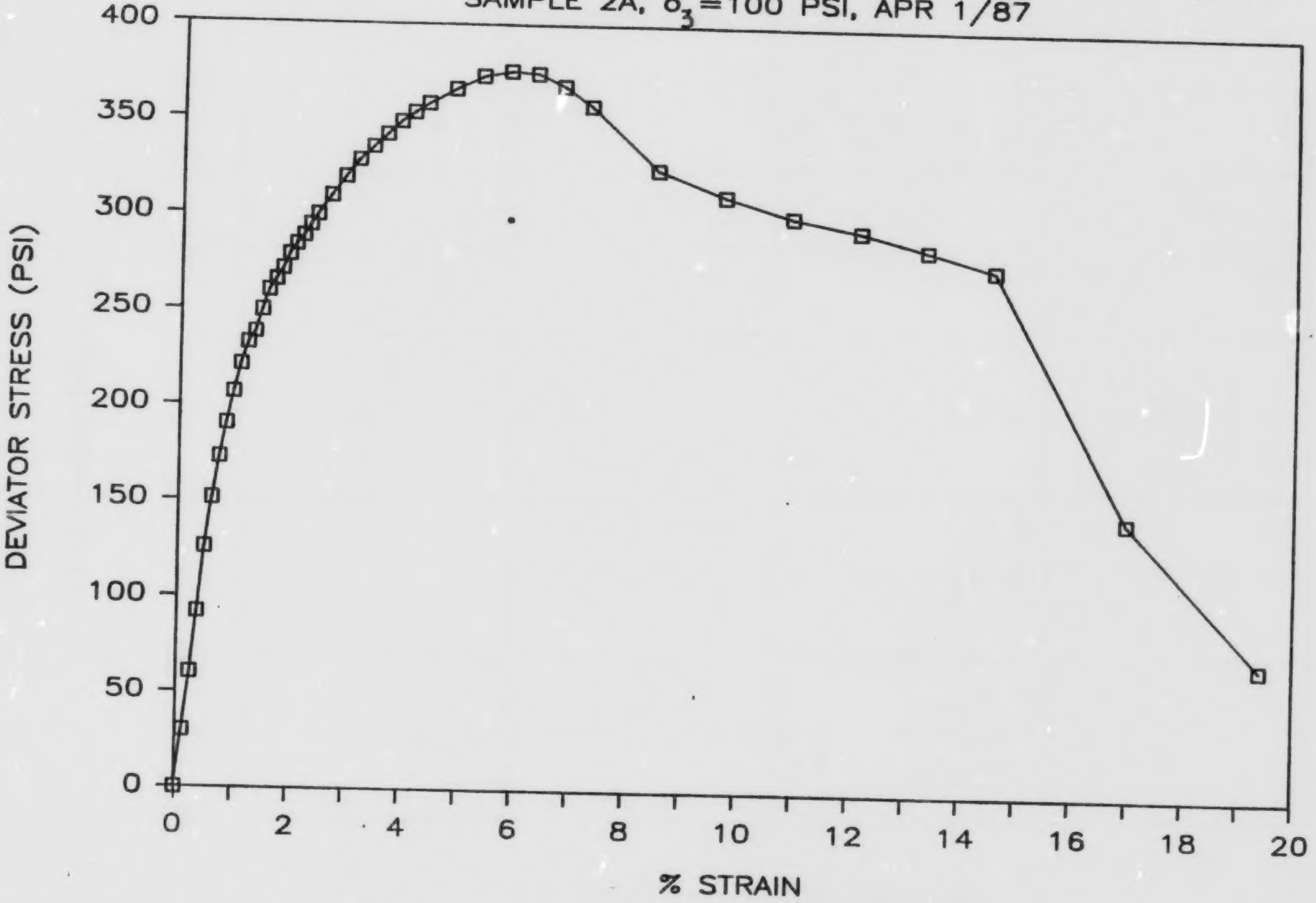
INCO–MINE BACKFILL, UU TEST #20

SAMPLE 4B, σ_3=50 PSI, APR 1/87

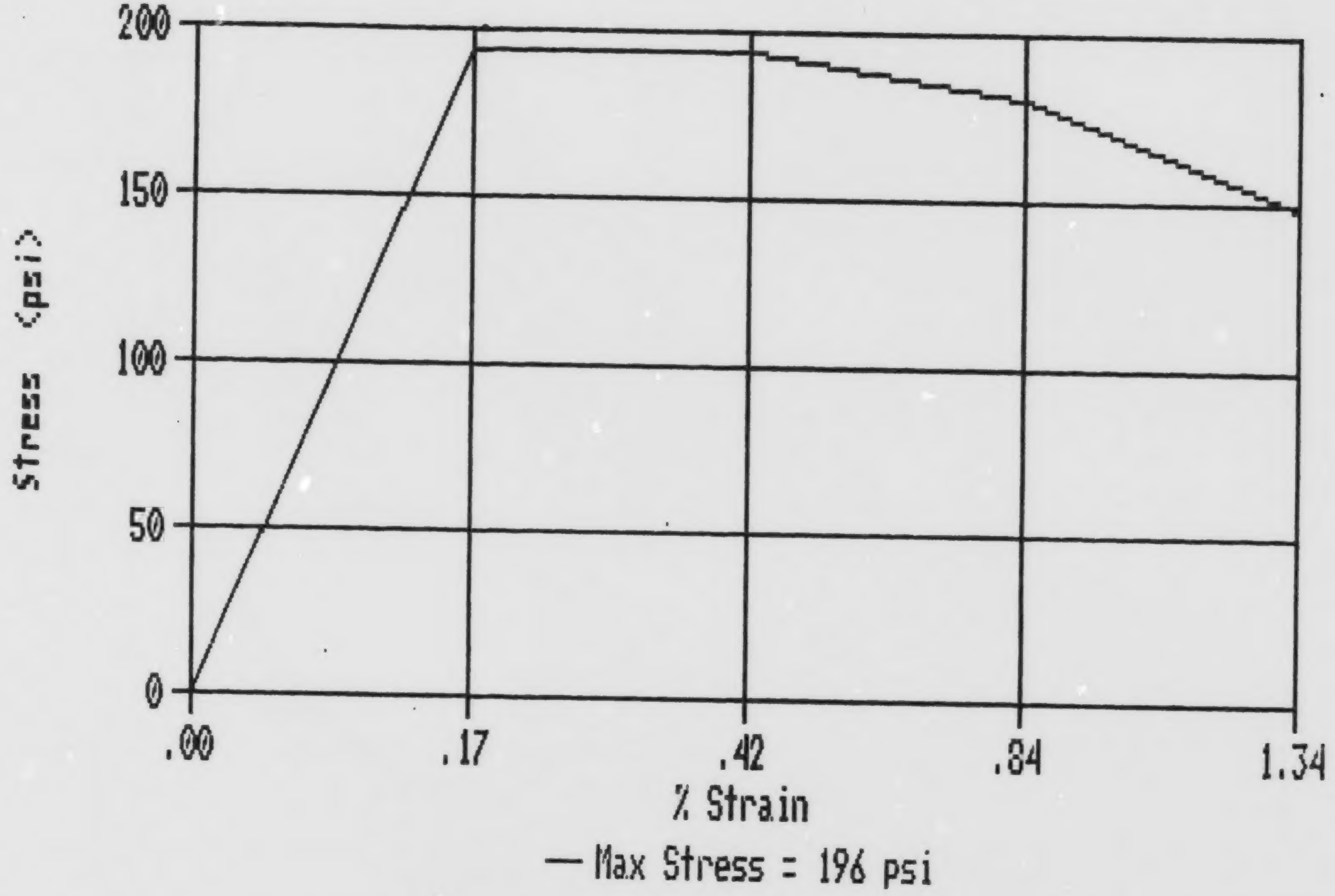


INCO—MINE BACKFILL, UU TEST #21

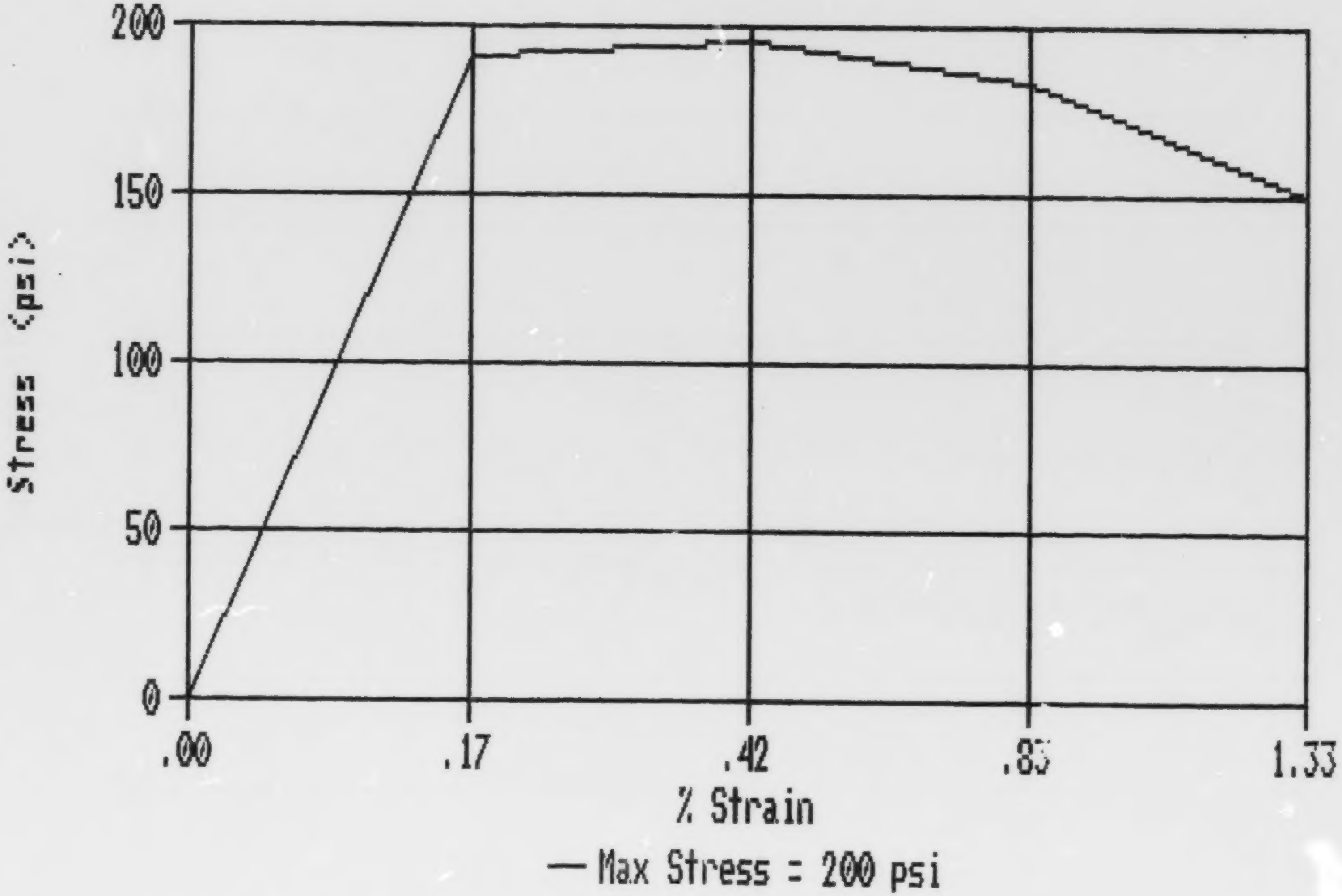
SAMPLE 2A, σ_3=100 PSI, APR 1/87



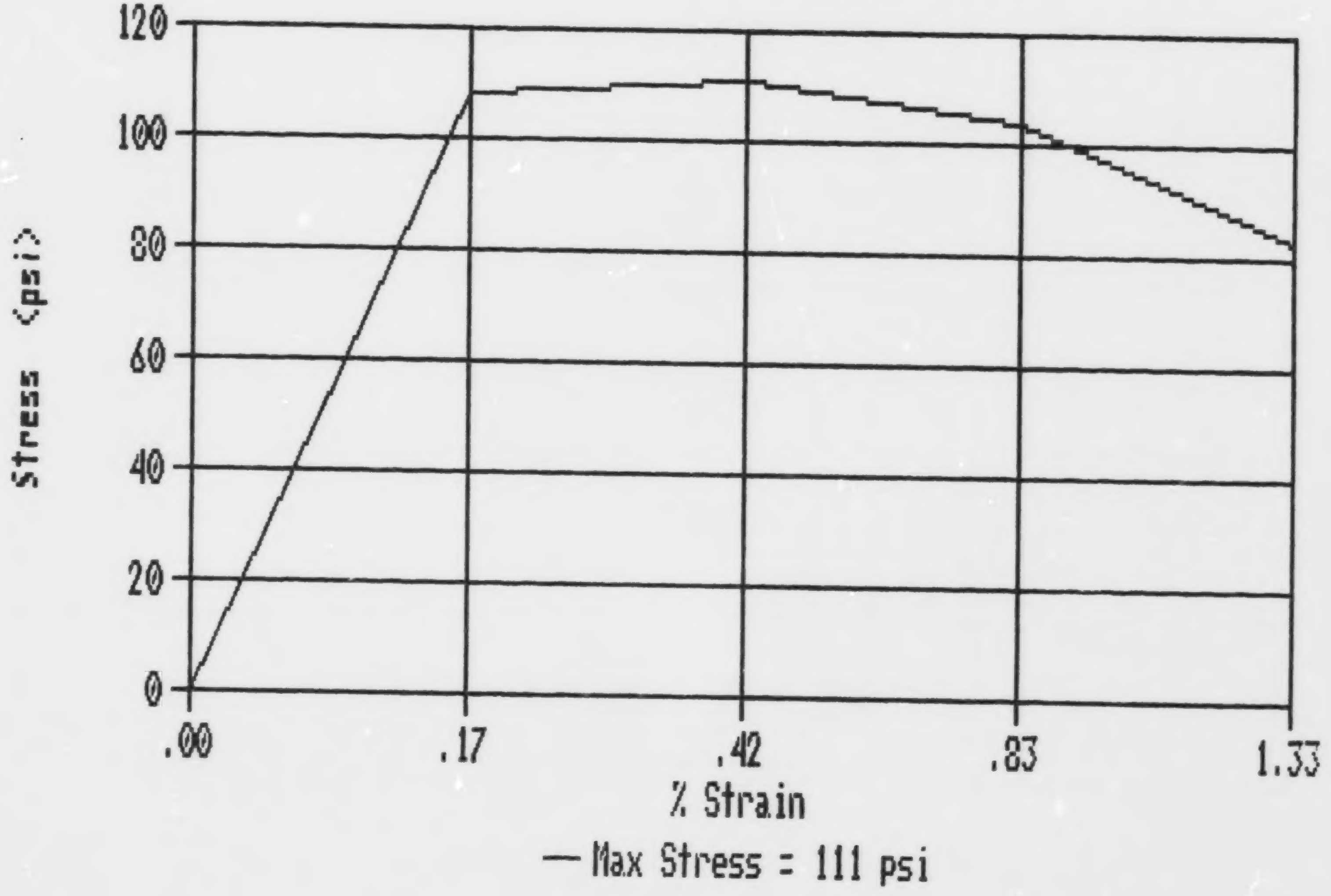
UNIAXIAL STRESS TEST
INCO Sample#5 7 Day Test Apr 15



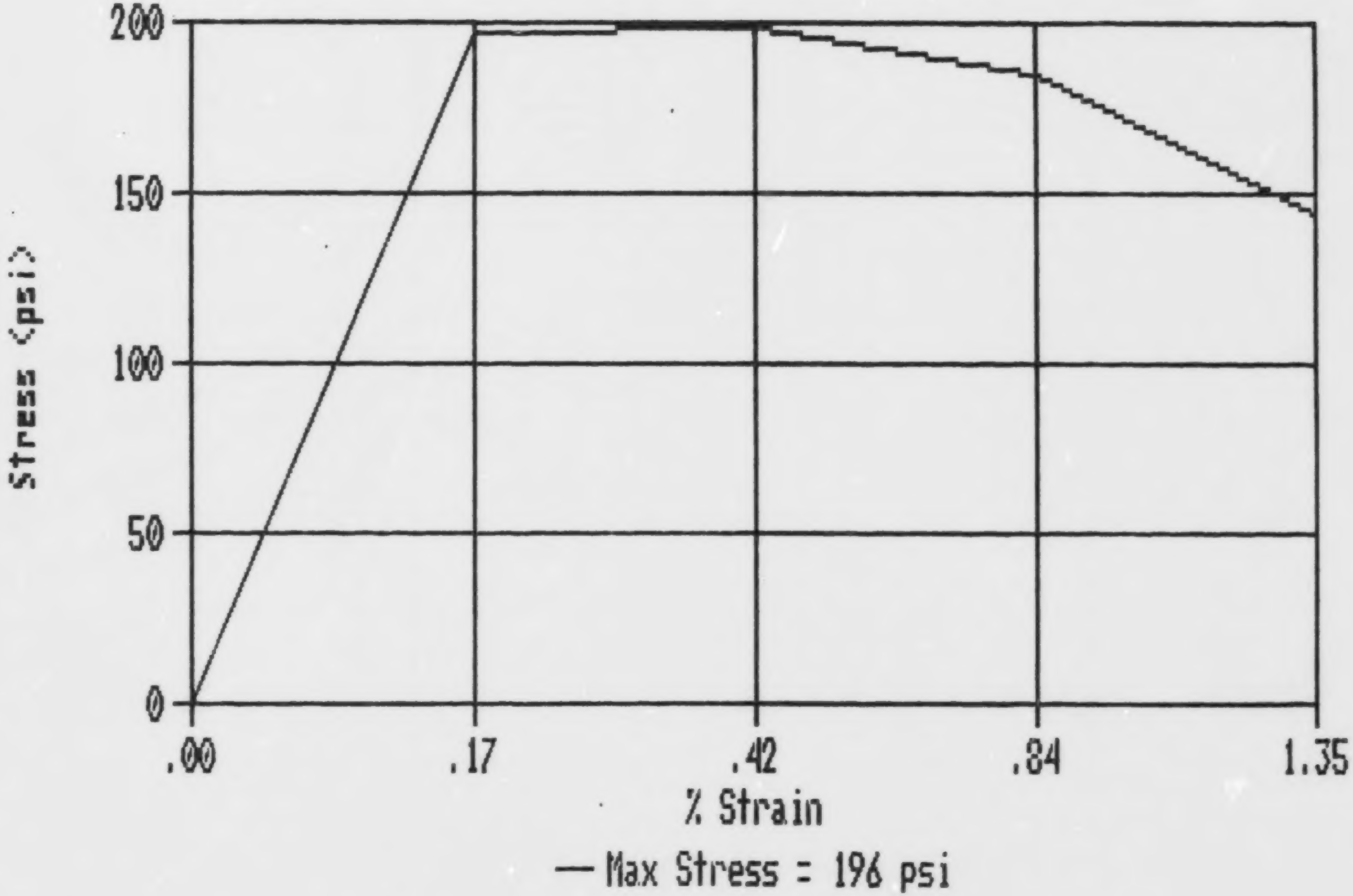
UNIAXIAL STRESS TEST
INCO Sample#7 7 Day Test Apr 15



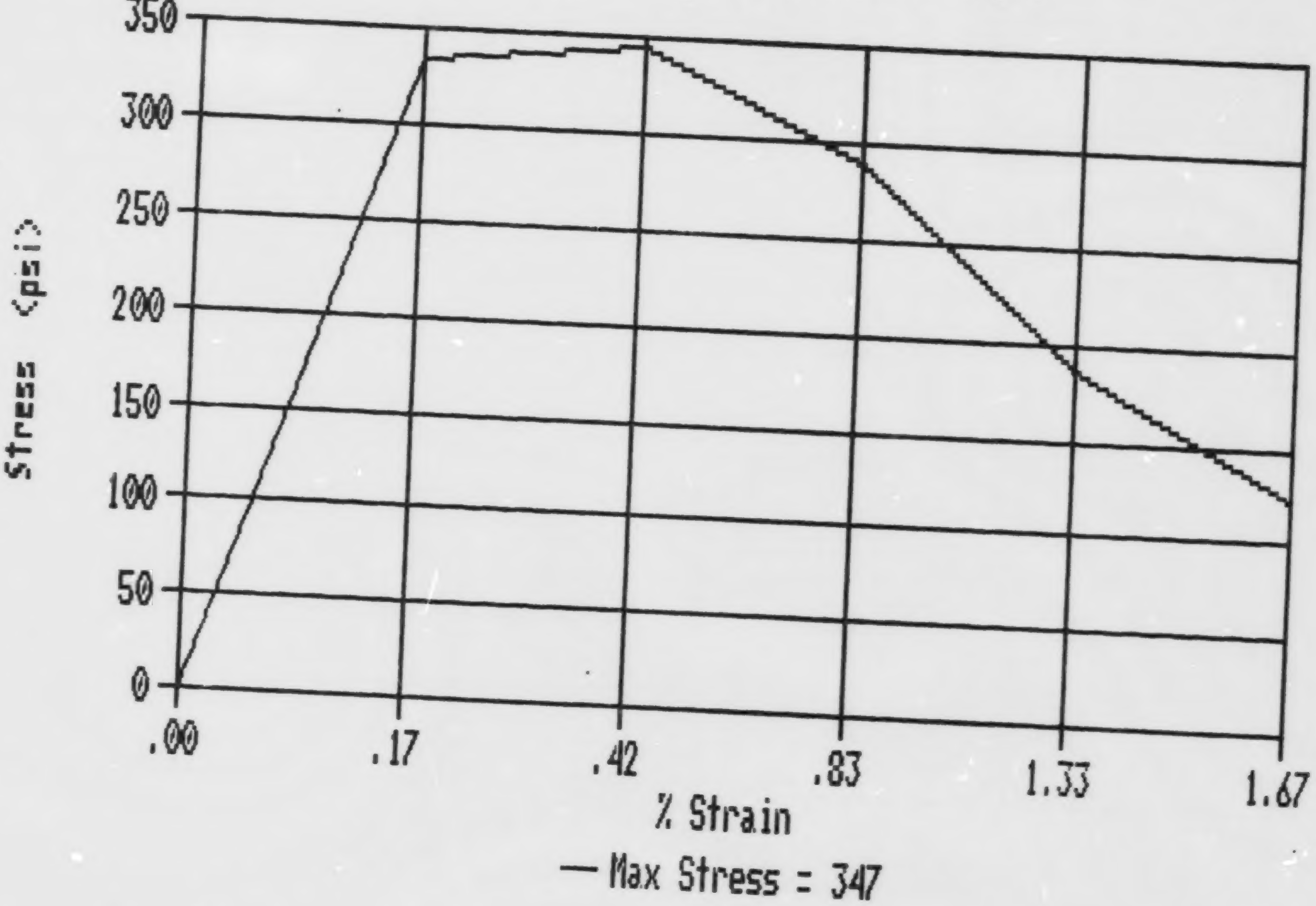
UNIAXIAL STRESS TEST
INCO Sample#9 7 Day Test Apr 15



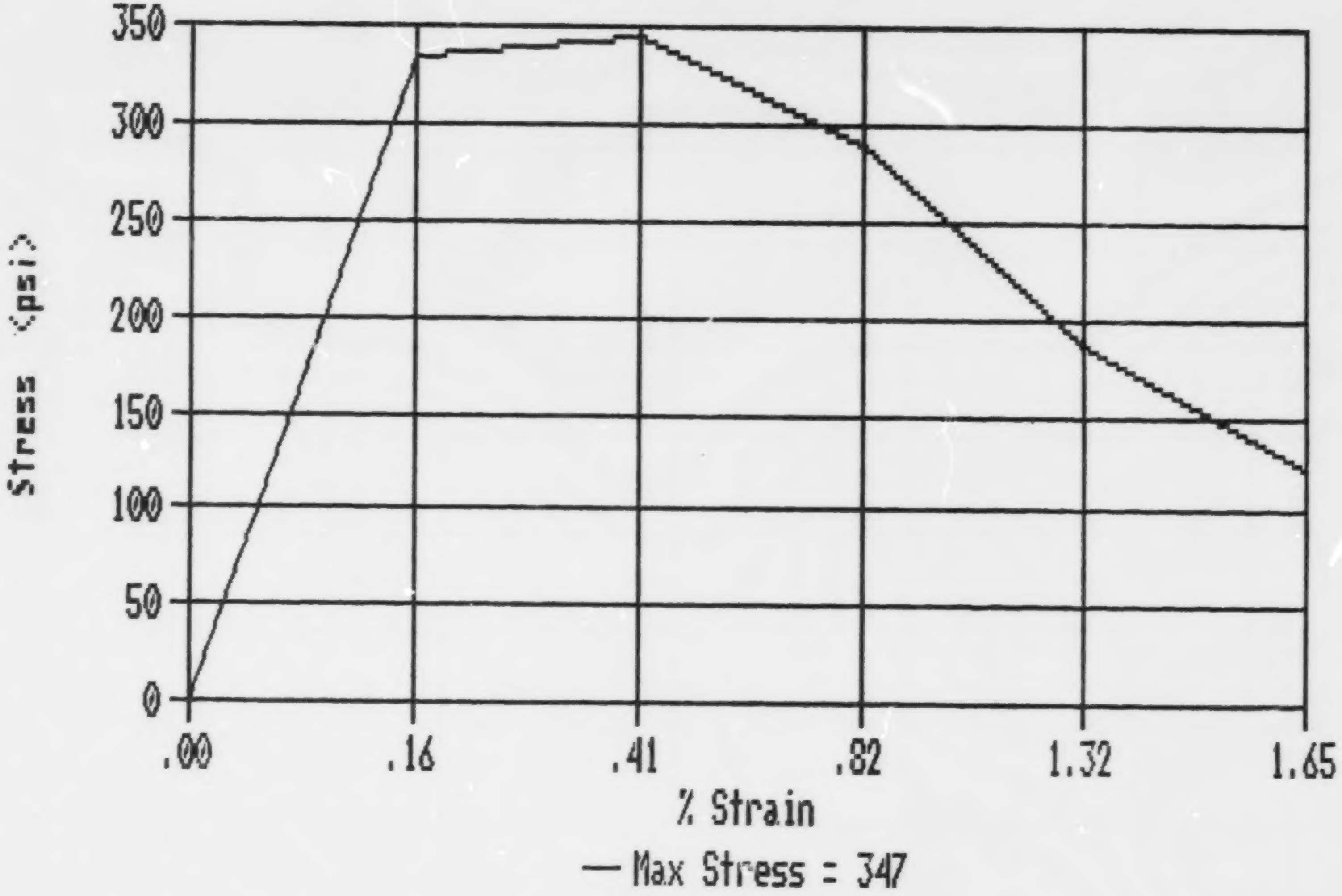
UNIAXIAL STRESS TEST
INCO Sample#13 7 Day Test Apr 15



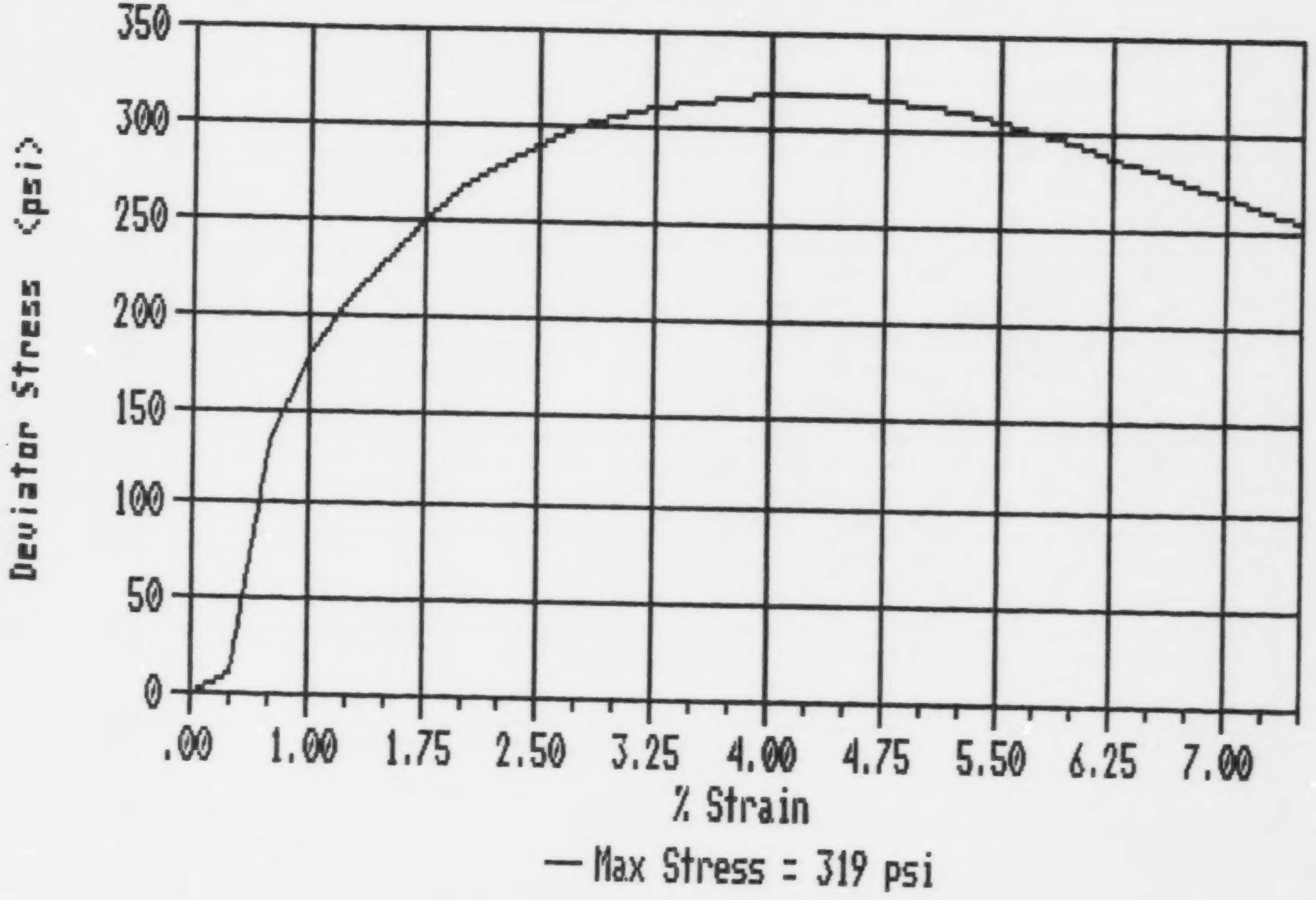
UNIAXIAL STRESS TEST
INCO Sample#4 28 Day Test May 6



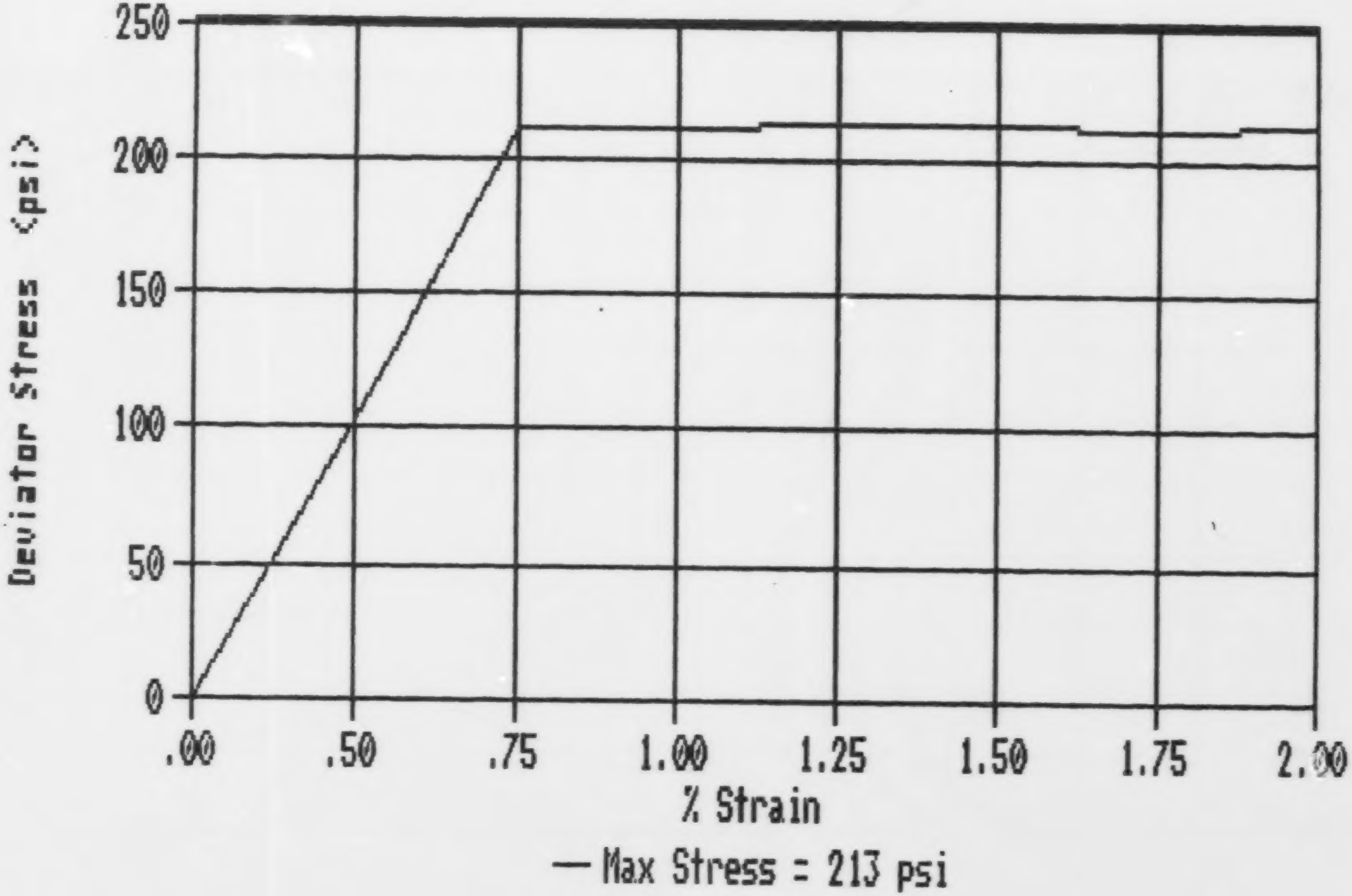
UNIAXIAL STRESS TEST
INCO Sample#11 28 Day Test May 6



TRIAXIAL STRESS TEST
INCO #6 Sig3= 100 psi 7 Days Apr 15

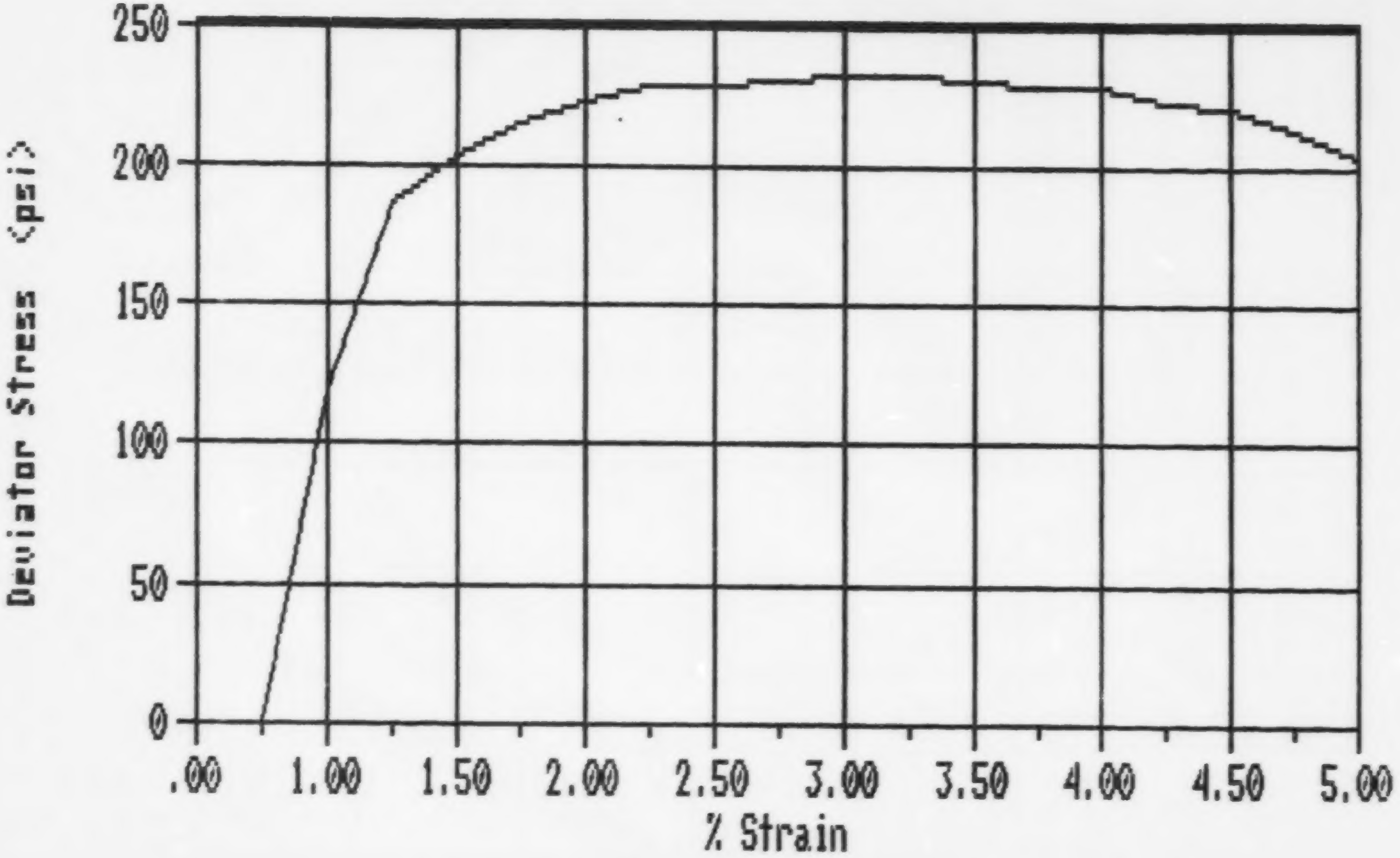


TRIAXIAL STRESS TEST
INCO #8 Sig3= 25 psi 7 Days Apr 15



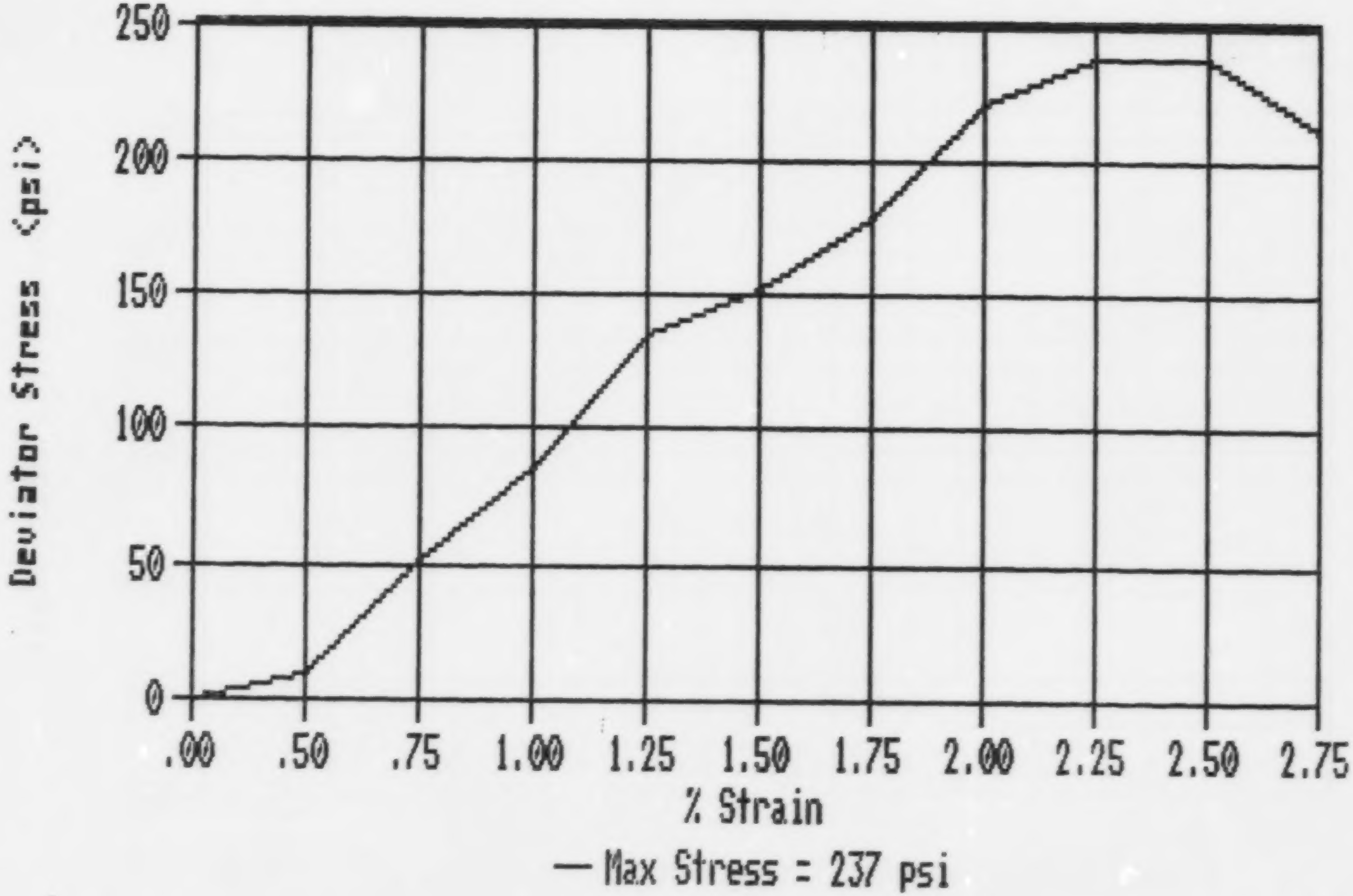
TRIAXIAL STRESS TEST

INCO #8A Sig3= 50 psi 7 Days Apr 15

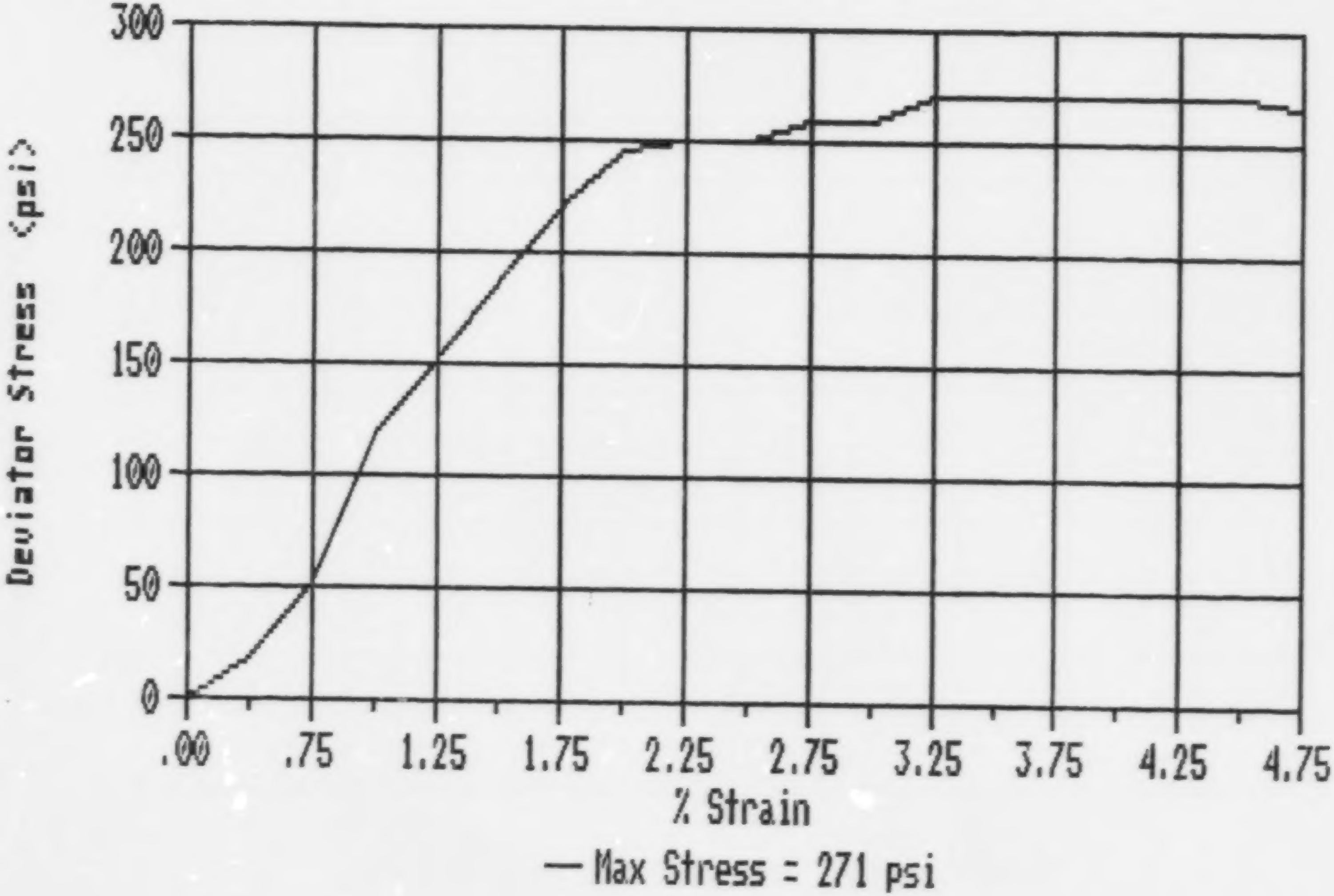


— Max Stress = 232 psi

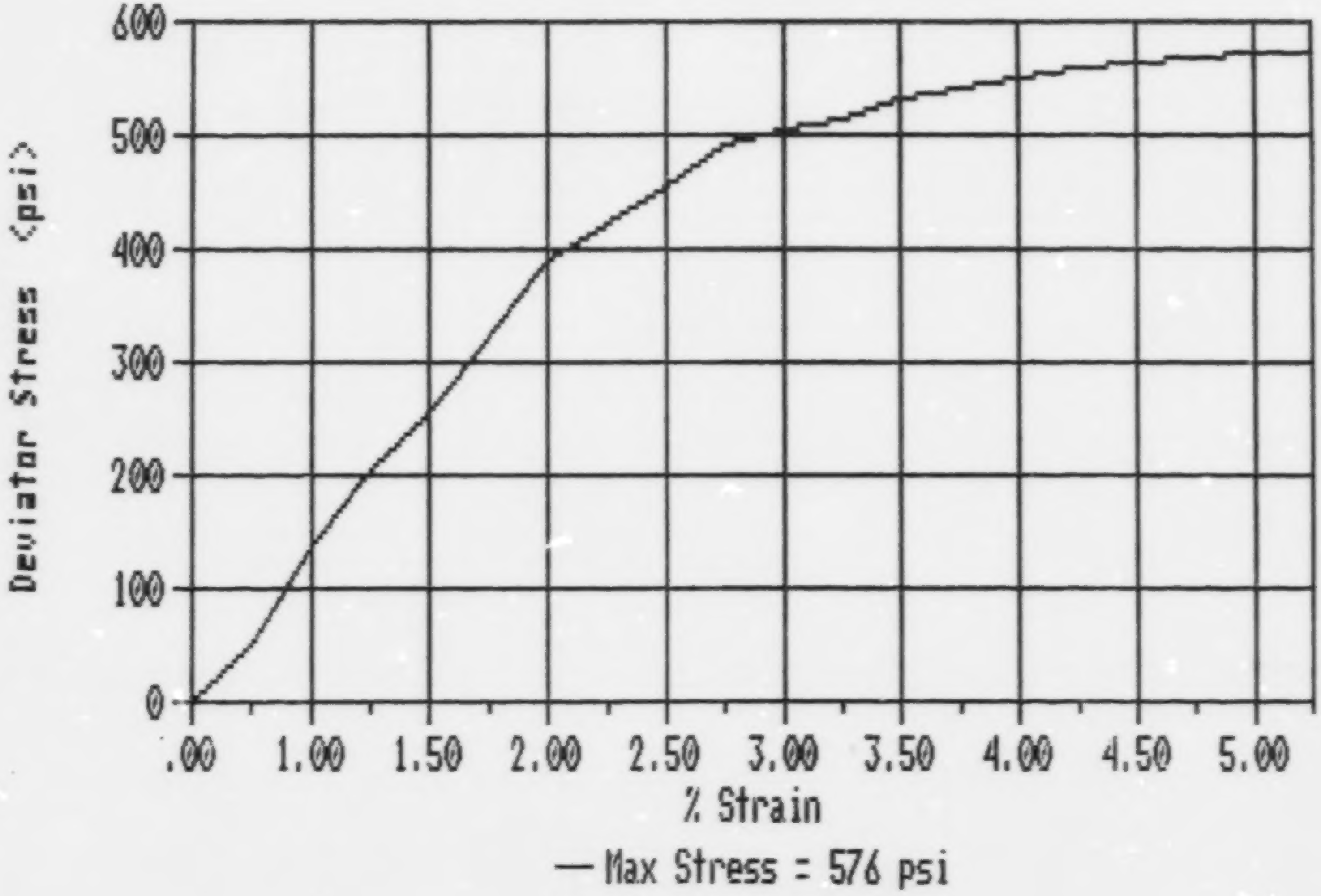
TRIAXIAL STRESS TEST
INCO #10 Sig3= 25 psi 28 Days May 6



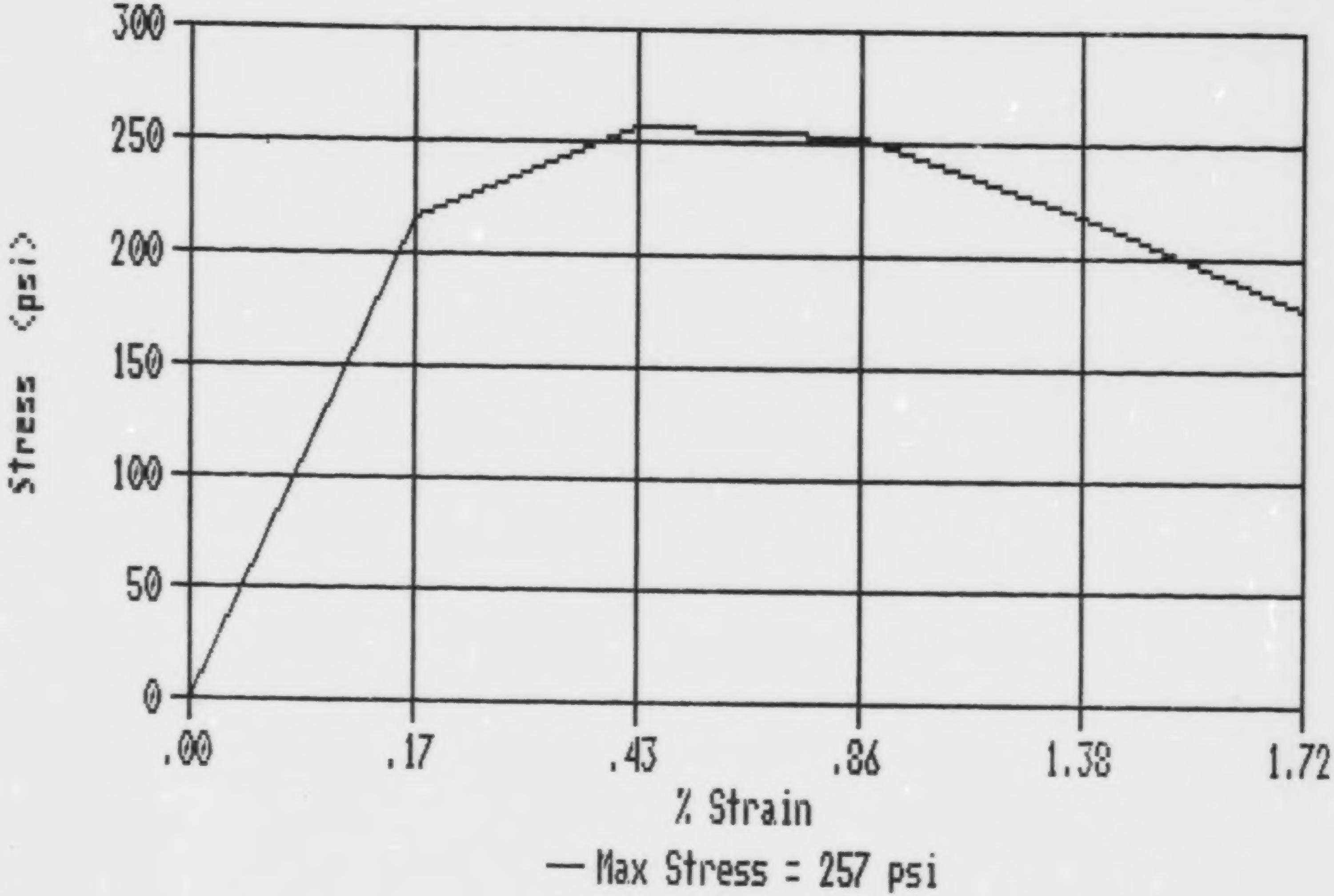
TRIAXIAL STRESS TEST
INCO #10A Sig3=50 psi 28 Days May 6



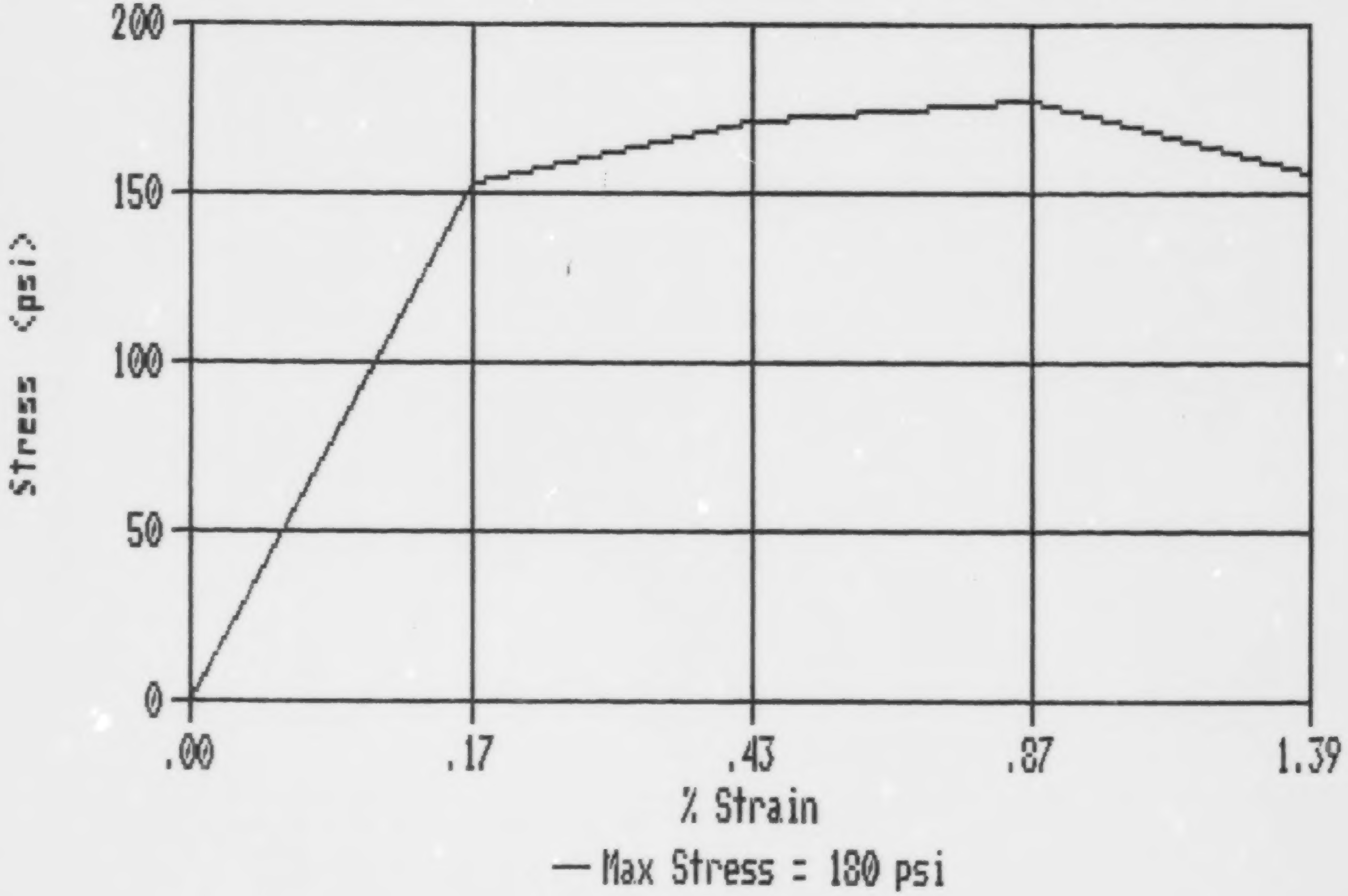
TRIAXIAL STRESS TEST
INCD #12 Sig3= 100psi 28 Days May 6



UNIAXIAL STRESS TEST
INCO Sample#1 28 Day Test May 7

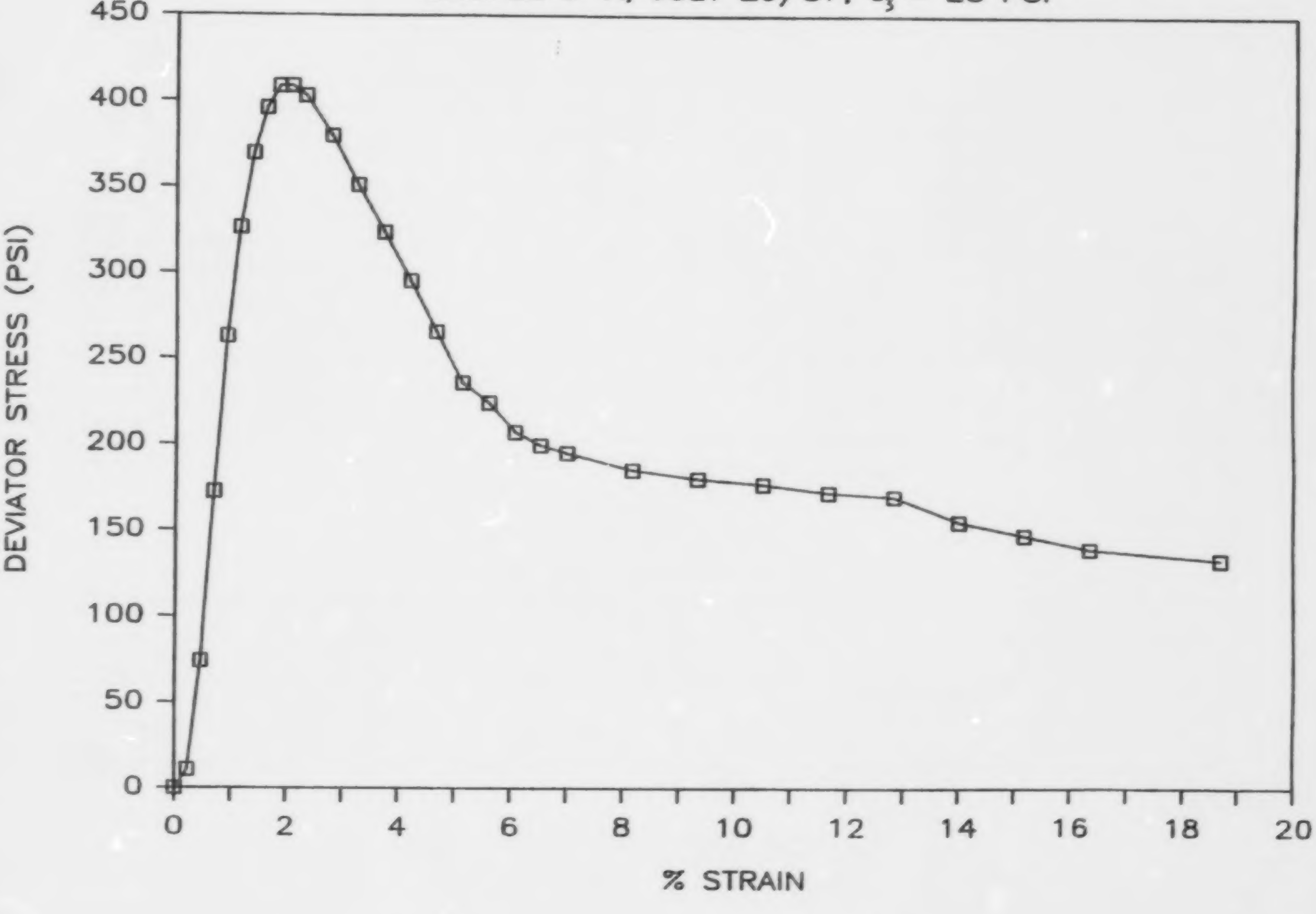


UNIAXIAL STRESS TEST
INCO Sample#2 7 Day Test Apr 16



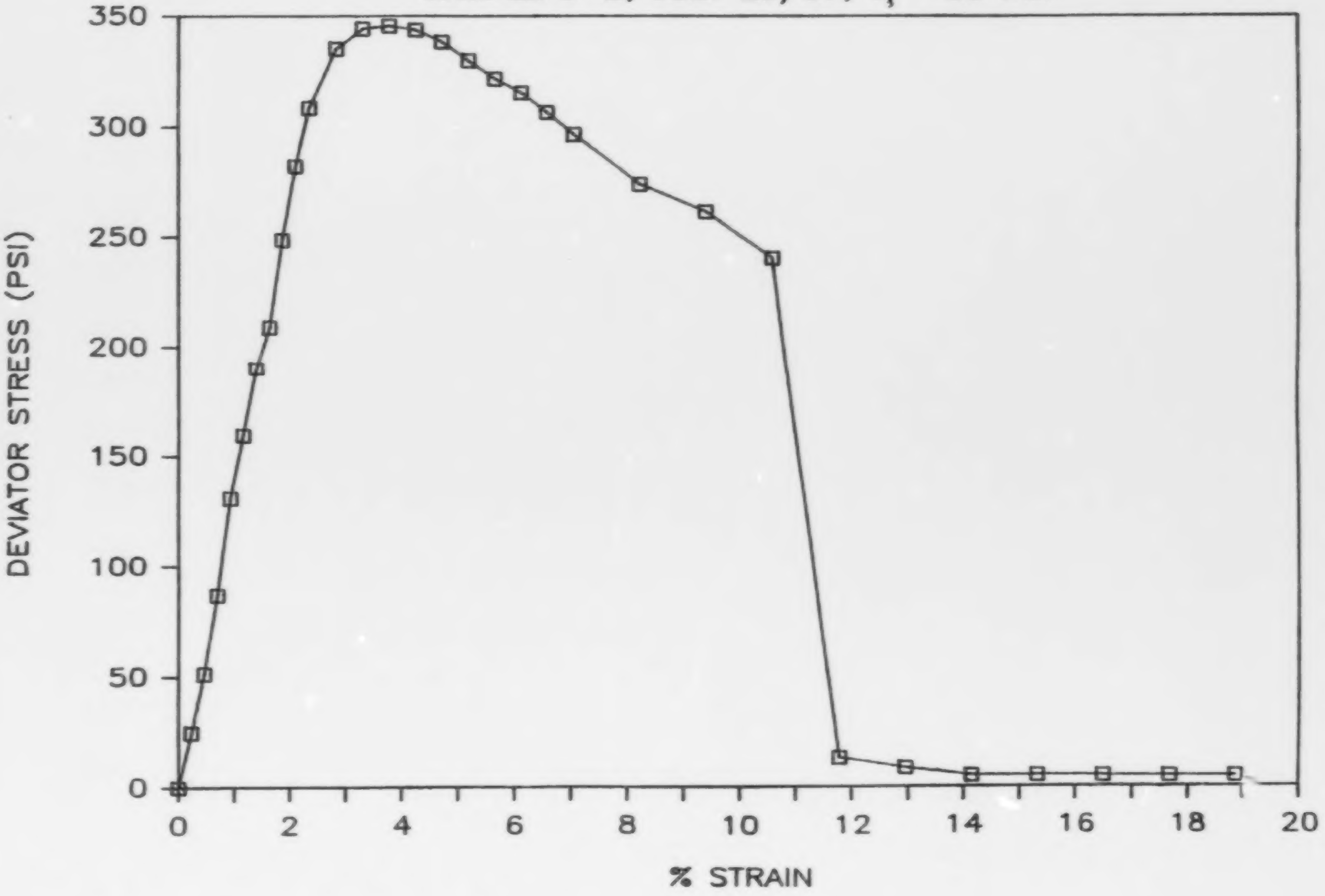
INCO MINE BACKFILL, UU TEST#25

SAMPLE 9-A, JULY 29/87, σ_3 = 25 PSI



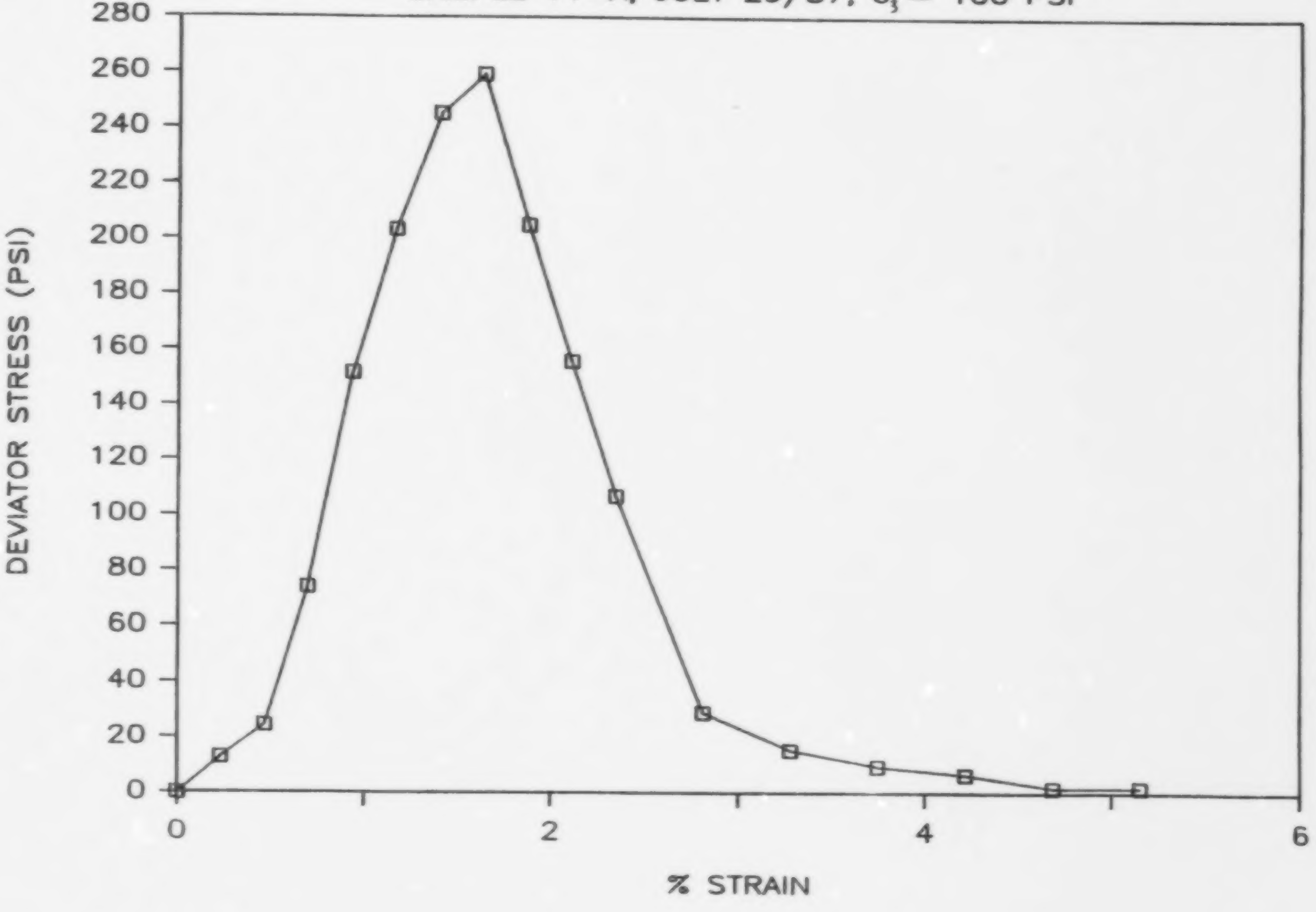
INCO MINE BACKFILL, UU TEST#26

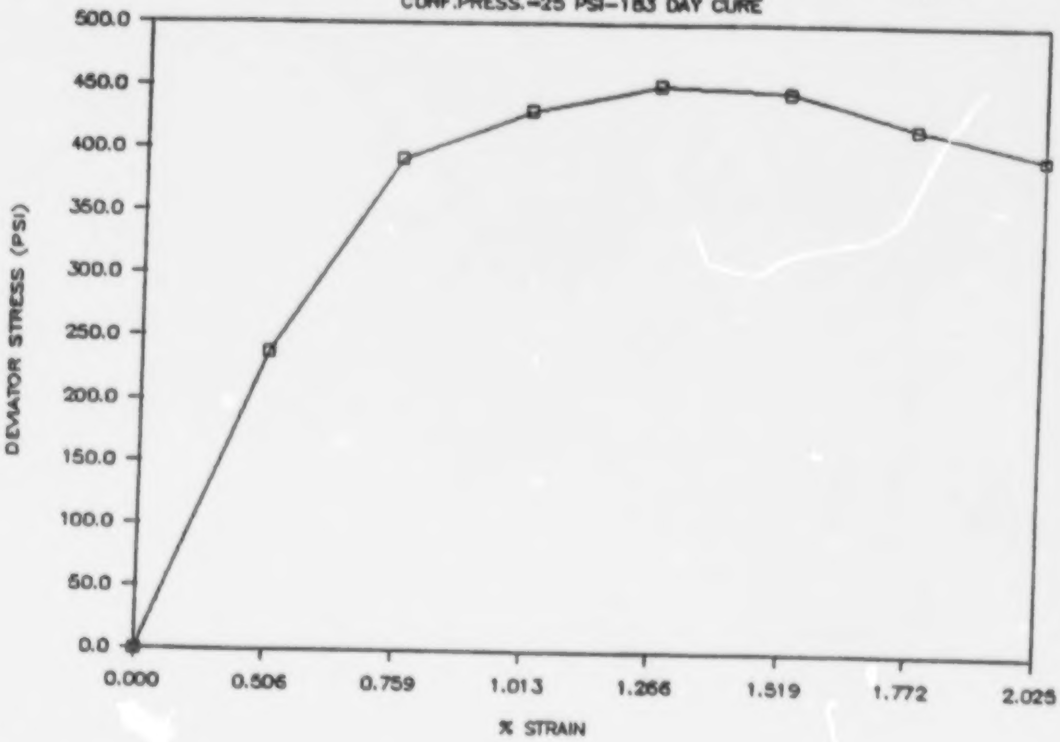
SAMPLE 9–B, JULY 29/87, σ_3 = 50 PSI



INCO MINE BACKFILL, UU TEST#27

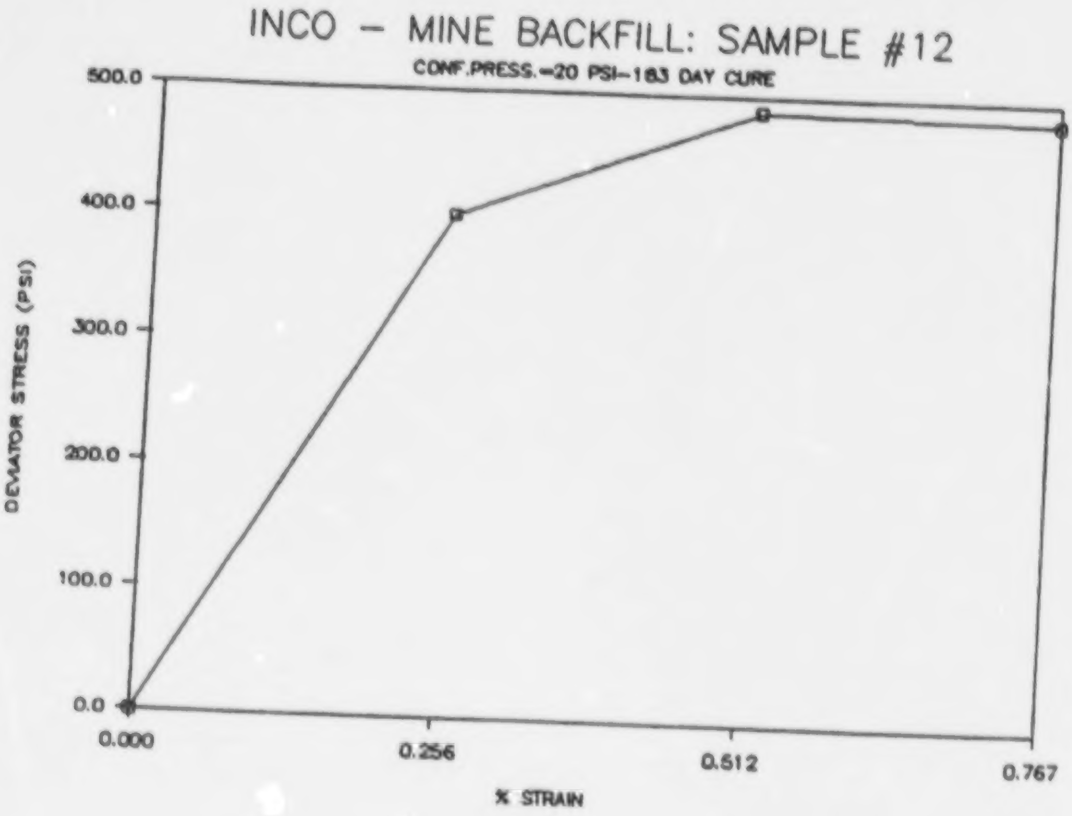
SAMPLE 11–A, JULY 29/87, σ_3 = 100 PSI

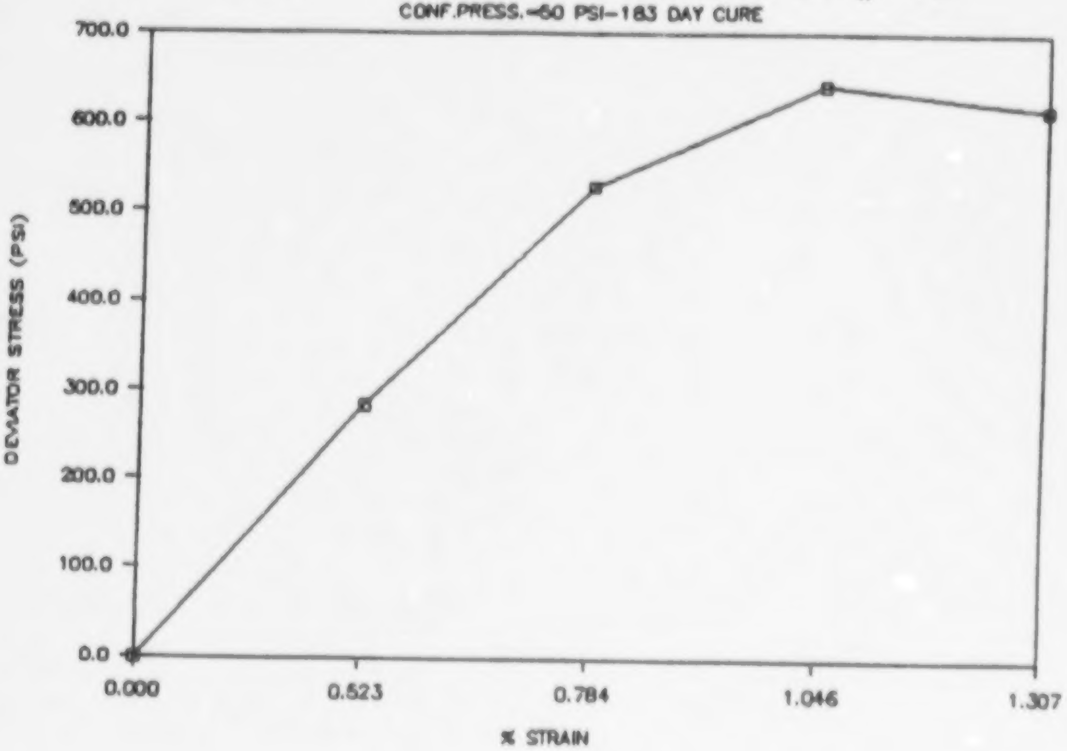




INCO – MINE BACKFILL: SAMPLE #8

CONF.PRESS.–25 PSI–183 DAY CURE


INCO - MINE BACKFILL: SAMPLE #12
CONF.PRESS.=20 PSI-183 DAY CURE
DEVIATOR STRESS (PSI)
500.0
400.0
300.0
200.0
100.0
0.0
0.000
0.256
0.512
0.767
% STRAIN



INCO – MINE BACKFILL: SAMPLE #14a

CONF.PRESS.-60 PSI-183 DAY CURE

INCO – MINE BACKFILL: SAMPLE #14b

CONF.PRESS.–100 PSI–183 DAY CURE

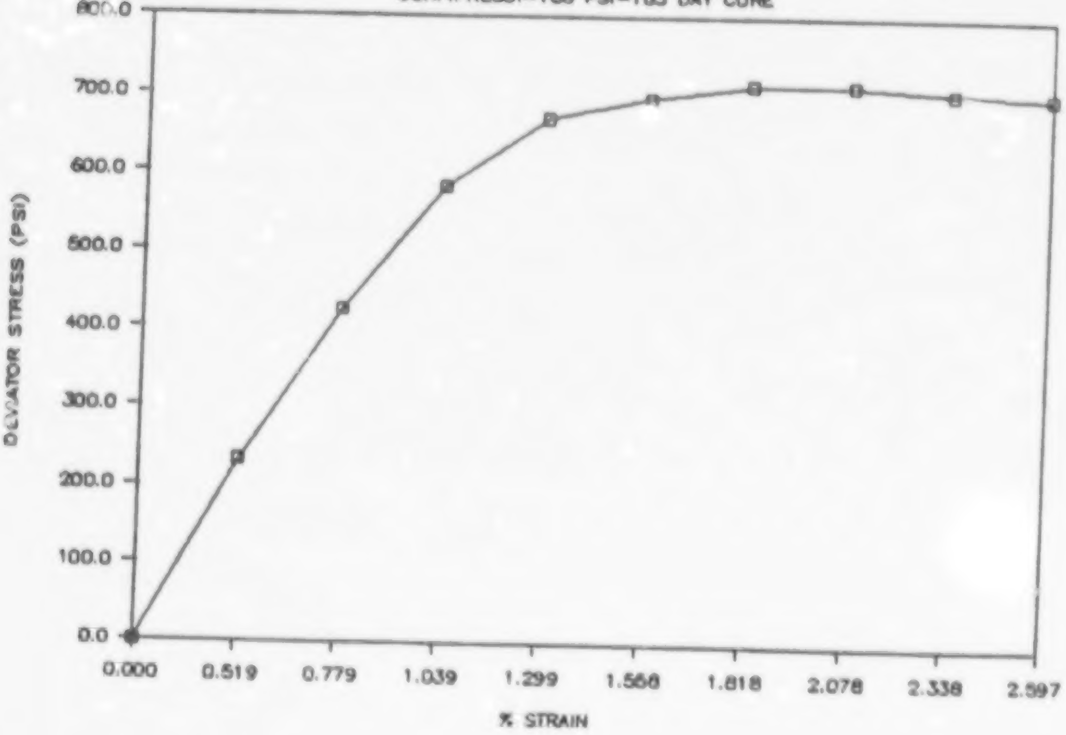


TABLE 3

7 Days Curing

SAMPLE NO.	σ_1 (psi)	σ_3 (psi)
2	250	0
6	200	0
10	140	0
13	245	0
15	173	0
17	148	0
19	280	0
1	147	0
3	138	0
5	196	0
7	200	0
9	111	0
13	196	0
2	180	0
14	341	25
18	306	25
8	238	25
16	475	50
20	385	50
8A	285	50
20A	592	100
6	419	100
16A	622	100

TABLE 4

28 Days Curing

SAMPLE NO.	σ_1 (psi)	σ_3 (psi)
4	335	0
8	293	0
12	242	0
21	37	0
23	30	0
4	347	0
11	347	0
1	257	0
7A	300	25
10	262	25
22A	325	25
4A	300	25
4B	390	50
10A	321	50
5A	400	50
22B	530	50
12	676	100
5B	260	100
24A	800	100
2A	485	100

TABLE 6

183 Days Curing

SAMPLE NO.	σ_1 (psi)	σ_3 (psi)
12	500	20
8	475	25
14A	700	50
14B	725	100

TABLE 5

168 Days Curing

SAMPLE NO.	σ_1 (psi)	σ_3 (psi)
9A	635	25
4A	520	25
6A	600	50
9B	395	50
6B	660	100
11A	360	100

Appendix C

In-Situ Monitoring Results

Table 1C

Data Collection Report Datalogger 1

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	8 5000 psi
	Cells:	200	203	179	205	189	190	182	183
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
08/18/87		263.83	982.11	616.51	-177.47	472.96	389.10	514.29	461.74
08/19/87		263.61	982.11	615.99	-180.36	472.59	388.93	513.82	461.88
08/20/87		262.86	982.11	615.56	-198.23	474.10	390.40	515.73	462.82
08/21/87		263.55	982.11	614.93	-193.13	474.27	390.79	515.43	462.99
08/22/87		263.65	982.11	614.04	-189.67	473.75	390.54	514.36	461.59
08/23/87		262.99	982.11	614.02	-201.03	475.38	392.09	516.39	462.81
08/24/87		262.65	982.11	613.86	-202.24	476.15	392.86	517.24	463.31
08/25/87		262.82	982.11	613.57	-201.43	476.41	393.22	517.28	463.64
08/26/87		262.70	982.11	613.34	-195.08	477.14	394.04	517.89	464.40
08/27/87		263.05	982.11	613.23	-197.83	477.16	394.21	517.34	464.69
08/28/87		263.10	982.11	613.16	-196.52	475.64	394.00	516.76	464.75
08/29/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/30/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/31/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/01/87		262.30	982.11	611.83	-230.62	478.44	396.05	517.54	466.08
09/02/87		261.84	982.11	612.16	-233.19	479.41	397.01	518.61	467.27
09/03/87		261.21	982.11	613.40	-240.85	480.59	398.19	520.37	468.51
09/04/87		262.17	982.11	613.63	-224.89	480.78	398.61	520.56	468.90
09/05/87		262.24	982.11	613.28	-224.44	480.42	398.54	519.68	468.58
09/06/87		262.40	982.11	612.84	-221.31	480.14	398.47	519.18	468.36
09/07/87		262.90	982.11	612.55	-224.44	480.22	399.66	519.03	468.47
09/08/87		262.30	982.11	612.91	-223.54	480.45	399.62	519.09	469.06
09/09/87		261.58	982.11	613.67	-223.25	480.56	399.76	518.91	469.36
09/10/87		261.17	982.11	613.89	-232.25	481.63	400.25	520.33	470.39
09/11/87		261.91	982.11	613.74	-225.80	481.69	400.38	520.20	470.50

Table 1C Continued

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	9 5000 psi
	Cells:	200	203	179	205	189	190	182	183
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
09/12/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/13/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/14/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/15/87		248.93	982.11	660.14	-797.28	485.23	400.12	524.73	474.70
09/16/87		260.69	982.11	618.52	n/a	486.98	402.07	527.00	475.86
09/17/87		376.22	893.89	610.91	437.19	530.97	446.77	631.44	535.45
09/18/87		560.81	784.11	714.43	721.63	718.34	586.48	850.60	749.36
09/19/87		337.93	915.81	655.08	485.10	576.67	434.19	616.19	554.60
09/20/87		125.84	982.11	823.40	783.79	820.43	670.68	948.13	834.49
09/21/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/22/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/23/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/24/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/25/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/26/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/27/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/28/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/29/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/30/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/01/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/02/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/03/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/04/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/05/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/06/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/07/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/08/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/09/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/10/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/11/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/12/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 1C Continued

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	8 5000 psi
	Cells:	200	203	179	205	189	190	162	183
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
10/13/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/14/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/15/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/16/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/17/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/18/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/19/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/20/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/21/87		252.27	982.11	617.43	n/a	499.29	417.41	508.95	481.28
10/22/87		251.21	982.11	617.07	n/a	499.92	418.39	509.64	481.68
10/23/87		248.53	982.11	621.13	n/a	485.01	408.41	493.39	471.64
10/24/87		249.61	982.11	617.61	n/a	471.59	399.23	483.65	460.26
10/25/87		250.68	982.11	618.32	n/a	476.49	402.95	488.85	461.16
10/26/87		251.21	982.11	618.32	n/a	477.88	404.53	498.85	460.72
10/27/87		251.21	982.11	619.90	n/a	474.75	401.37	483.65	458.51
10/28/87		255.42	982.11	623.73	n/a	483.67	407.96	488.85	458.95
10/29/87		255.93	982.11	625.80	n/a	490.30	412.46	495.61	460.28
10/30/87		340.62	982.11	657.61	n/a	404.93	333.71	508.59	427.87
10/31/87		347.02	982.11	667.90	n/a	413.69	341.83	514.83	431.95
11/01/87		347.97	982.11	667.47	n/a	421.70	349.62	517.89	433.46
11/02/87		343.53	982.11	666.62	n/a	425.17	354.07	518.40	433.46
11/03/87		350.76	982.11	667.61	n/a	425.60	355.09	513.80	430.94
11/04/87		347.34	982.11	669.31	n/a	429.44	359.42	515.34	429.92
11/05/87		350.45	982.11	670.01	n/a	434.88	363.99	518.91	431.44
11/06/87		351.07	982.11	673.76	n/a	438.58	363.99	521.42	431.95
11/07/87		407.95	982.11	713.65	740.91	349.63	n/a	489.99	n/a
11/08/87		403.16	982.11	711.57	731.96	348.44	n/a	490.56	n/a
11/09/87		399.42	982.11	709.59	641.04	349.04	n/a	494.50	n/a
11/10/87		398.47	982.11	707.58	637.36	350.61	n/a	497.27	n/a
11/11/87		[illegible]	982.11	712.62	377.41	349.63	n/a	560.56	n/a
11/12/87		403.35	982.11	754.09	347.85	346.04	n/a	523.41	n/a

Table 1C Continued

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	8 5000 psi
	Cells:	200	203	179	205	189	190	182	183
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
11/13/87		399.18	982.11	755.05	366.08	343.62	n/a	526.36	n/a
11/14/87		402.00	982.11	755.33	391.28	344.23	n/a	526.36	n/a
11/15/87		395.36	982.11	753.99	418.63	346.04	n/a	529.77	n/a
11/16/87		392.69	982.11	750.02	447.04	345.44	n/a	528.32	n/a
11/17/87		407.50	982.11	775.06	n/a	343.01	n/a	529.77	n/a
11/18/87		406.82	982.11	774.36	n/a	341.17	n/a	531.69	n/a
11/19/87		411.96	982.11	785.39	n/a	343.62	n/a	541.09	n/a
11/20/87		401.53	982.11	792.70	-248.81	341.79	n/a	539.71	n/a
11/21/87		395.85	982.11	784.55	49.54	341.79	n/a	539.24	n/a
11/22/87		390.72	982.11	781.01	247.31	341.17	n/a	537.84	n/a
11/23/87		385.45	982.11	763.95	298.06	339.32	n/a	535.50	n/a
11/24/87		389.23	982.11	327.96	271.31	340.56	n/a	542.93	n/a
11/25/87		383.91	982.11	329.26	285.59	342.40	n/a	542.47	n/a
11/26/87		379.49	982.11	330.56	173.67	341.79	n/a	541.55	n/a
11/27/87		379.49	982.11	331.84	392.92	343.01	n/a	544.30	n/a
11/28/87		365.19	982.11	331.84	363.57	343.62	n/a	542.01	n/a
11/29/87		385.96	982.11	332.49	416.68	339.94	n/a	538.78	n/a
11/30/87		387.73	982.11	332.49	344.42	338.70	n/a	536.44	n/a
12/01/87		389.98	982.11	331.84	362.30	338.70	n/a	536.91	n/a
12/02/87		390.72	982.11	331.20	377.00	338.08	n/a	536.91	n/a
12/03/87		389.73	982.11	332.49	349.89	341.17	n/a	541.55	n/a
12/04/87		385.96	982.11	335.03	406.69	339.32	n/a	539.71	n/a
12/05/87		396.81	982.11	335.03	400.45	340.56	n/a	537.84	n/a
12/06/87		396.81	962.11	334.40	381.10	341.79	n/a	533.78	n/a
12/07/87		396.09	982.11	334.40	385.12	343.01	n/a	539.71	n/a
12/08/87		394.64	982.11	333.76	415.71	341.79	n/a	537.38	n/a
12/09/87		393.91	982.11	333.12	409.27	339.32	n/a	534.08	n/a
12/10/87		395.36	982.11	332.49	490.58	336.76	n/a	533.60	n/a
12/11/87		395.36	982.11	332.49	490.58	338.70	n/a	533.60	n/a
12/12/87		408.40	982.11	333.12	n/a	338.76	n/a	529.29	n/a
12/13/87		417.17	982.11	332.49	n/a	342.40	n/a	532.17	n/a

Table 1C Continued

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	8 5000 psi
	Cells:	200	203	179	205	189	190	182	183
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
12/14/87		424.72	982.11	331.84	n/a	346.04	n/a	535.02	n/a
12/15/87		429.58	982.11	331.20	n/a	346.04	n/a	535.50	n/a
12/16/87		433.34	982.11	329.91	n/a	343.62	n/a	535.97	n/a
12/17/87		437.60	982.11	329.26	n/a	347.24	n/a	540.63	n/a
12/18/87		443.26	982.11	328.61	n/a	349.04	n/a	539.71	n/a
12/19/87		445.65	982.11	329.26	n/a	347.24	n/a	540.63	n/a
12/20/87		446.75	982.11	327.96	n/a	346.04	n/a	540.17	n/a
12/21/87		448.38	982.11	328.61	n/a	346.04	n/a	542.93	n/a
12/22/87		450.00	982.11	329.26	n/a	346.64	n/a	544.75	n/a
12/23/87		451.60	982.11	328.61	n/a	347.84	n/a	547.01	n/a
12/24/87		453.01	982.11	328.61	n/a	349.63	n/a	549.25	n/a
12/25/87		453.36	982.11	328.61	n/a	348.44	n/a	549.25	n/a
12/26/87		454.59	982.11	328.61	n/a	350.22	n/a	551.92	n/a
12/27/87		455.28	982.11	327.96	n/a	349.63	n/a	551.92	n/a
12/28/87		455.98	982.11	328.61	n/a	351.40	n/a	554.11	n/a
12/29/87		455.80	982.11	328.61	n/a	351.40	n/a	554.98	n/a
12/30/87		456.49	982.11	327.30	n/a	351.99	n/a	555.85	n/a
12/31/87		456.27	982.11	335.97	n/a	349.38	n/a	556.30	n/a
01/01/88		455.63	982.11	331.20	n/a	348.44	n/a	554.98	n/a
01/02/88		456.15	982.11	331.20	n/a	350.81	n/a	555.85	n/a
01/03/88		458.38	982.11	330.56	n/a	350.81	n/a	547.01	n/a
01/04/88		458.21	982.11	329.91	n/a	350.81	n/a	549.25	n/a
01/05/88		457.36	982.11	330.56	n/a	353.16	n/a	551.92	n/a
01/06/88		458.04	982.11	329.91	n/a	354.91	n/a	553.67	n/a
01/07/88		459.23	982.11	329.91	n/a	354.33	n/a	551.03	n/a
01/08/88		460.93	982.11	332.49	n/a	353.16	n/a	552.80	n/a
01/09/88		462.10	982.11	329.26	n/a	353.16	n/a	546.56	n/a
01/10/88		464.92	982.11	330.56	n/a	354.91	n/a	547.01	n/a
01/11/88		465.42	982.11	330.56	n/a	353.75	n/a	546.56	n/a
01/12/88		465.75	982.11	331.84	n/a	353.16	n/a	547.45	n/a
01/13/88		466.40	982.11	330.56	n/a	353.16	n/a	548.36	n/a

Table IC Continued

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	8 5000 psi
	Cells:	200	203	179	205	189	190	182	183
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
01/14/88		468.03	982.11	331.84	n/a	356.65	n/a	551.03	n/a
01/15/88		468.19	982.11	332.49	n/a	353.75	n/a	548.76	n/a
01/16/88		469.48	982.11	331.20	n/a	353.16	n/a	547.46	n/a
01/17/88		470.12	982.11	333.12	n/a	353.16	n/a	548.81	n/a
01/18/88		470.76	982.11	332.49	n/a	353.16	n/a	549.25	n/a

Table 1C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	177	185	213	214	215	217	194	216
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
08/18/87		561.16	1084.08	630.10	880.79	366.26	318.35	423.43	n/a
08/19/87		560.65	1084.08	630.18	880.79	365.01	317.84	421.95	n/a
08/20/87		562.07	1084.08	630.49	880.79	363.91	317.59	422.24	n/a
08/21/87		562.23	1084.08	629.96	880.79	362.73	317.27	423.67	n/a
08/22/87		561.42	1084.08	629.31	880.79	361.00	316.84	422.52	n/a
08/23/87		562.77	1084.08	629.56	880.79	360.50	316.59	423.01	n/a
08/24/87		563.33	1084.08	629.35	880.79	359.69	316.47	423.99	n/a
08/25/87		563.25	1084.08	629.00	880.79	358.85	316.36	424.30	n/a
08/26/87		563.62	1084.08	628.75	880.79	357.60	316.14	424.93	n/a
08/27/87		563.45	1084.08	628.51	880.79	356.77	316.03	425.24	n/a
08/28/87		562.82	1084.08	628.41	880.79	356.89	316.15	424.78	n/a
08/29/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/30/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/31/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/01/87		563.38	1084.08	627.02	880.79	351.06	314.34	423.43	n/a
09/02/87		563.91	1084.08	626.86	880.79	349.66	313.96	423.01	n/a
09/03/87		564.71	1084.08	626.82	880.79	349.31	314.13	424.33	n/a
09/04/87		564.57	1084.08	626.25	880.79	349.07	314.29	425.95	n/a
09/05/87		563.93	1084.08	625.52	880.79	348.13	314.09	426.52	n/a
09/06/87		563.58	1084.08	625.07	880.79	346.63	313.66	426.32	n/a
09/07/87		563.45	1084.08	624.82	880.79	346.13	313.53	426.46	n/a
09/08/87		563.43	1084.08	624.53	880.79	345.64	313.64	427.39	n/a
09/09/87		563.19	1084.08	624.04	880.79	345.15	313.59	427.39	n/a
09/10/87		563.64	1084.08	624.13	880.79	345.11	313.57	428.27	n/a
09/11/87		563.73	1084.08	623.80	880.79	344.73	313.89	428.85	n/a

Table 1C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	177	185	213	214	215	217	194	216
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
09/12/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/13/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/14/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/15/87		586.01	1084.68	661.56	438.74	379.61	323.76	422.54	-241.35
09/16/87		592.40	1084.60	663.29	437.75	367.35	322.47	421.69	n/a
09/17/87		600.56	960.79	647.01	466.06	435.25	338.74	547.50	419.57
09/18/87		787.82	860.27	816.59	663.25	671.33	491.01	833.53	779.21
09/19/87		633.54	995.53	683.56	569.75	533.66	404.35	650.16	537.12
09/20/87		891.50	1084.43	934.15	775.79	409.53	338.95	432.36	n/a
09/21/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/22/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/23/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/24/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/25/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/26/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/27/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/28/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/29/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/30/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/01/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/02/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/03/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/04/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/05/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/06/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/07/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/08/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/09/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/10/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/11/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/12/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 1C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	177	185	213	214	215	217	194	216
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
10/13/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/14/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/15/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/16/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/17/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/18/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/19/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/20/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/21/87		597.55	1084.08	657.44	880.79	400.63	343.56	451.56	404.32
10/22/87		598.11	1084.08	656.95	880.79	401.42	343.99	455.22	406.19
10/23/87		578.85	1084.08	650.97	880.79	411.05	348.29	458.94	406.81
10/24/87		560.45	1084.08	641.78	880.79	412.92	348.26	437.74	406.19
10/25/87		563.99	1084.08	642.30	880.79	411.05	347.15	437.41	407.69
10/26/87		564.95	1084.08	641.52	880.79	409.15	346.32	438.31	403.69
10/27/87		559.48	1084.08	639.95	880.79	411.05	346.74	437.66	403.05
10/28/87		560.45	1084.08	640.47	880.79	403.77	343.13	437.66	n/a
10/29/87		563.99	1084.08	641.26	880.79	405.32	343.56	442.81	n/a
10/30/87		610.99	1084.08	600.42	880.79	545.11	443.96	703.73	449.24
10/31/87		616.39	1084.08	610.98	880.79	505.63	451.41	706.85	n/a
11/01/87		619.43	1084.08	611.87	880.79	465.54	447.96	706.63	n/a
11/02/87		620.16	1084.08	611.50	880.79	435.36	445.51	705.52	n/a
11/03/87		620.18	1084.08	614.21	880.79	416.63	444.67	701.71	n/a
11/04/87		623.17	1084.08	615.38	880.79	395.64	442.73	703.95	n/a
11/05/87		625.63	1084.08	616.54	880.79	378.71	441.99	706.18	n/a
11/06/87		628.06	1084.08	618.26	880.79	363.97	442.61	712.32	n/a
11/07/87		476.41	1084.08	535.87	880.79	500.57	337.69	810.27	669.24
11/08/87		478.27	1084.08	541.03	880.79	475.74	337.69	803.96	632.53
11/09/87		481.03	1084.08	542.60	880.79	456.74	337.69	714.26	623.05
11/10/87		483.77	1084.08	544.93	880.79	429.40	336.58	789.86	n/a
11/11/87		485.12	1084.08	546.85	880.79	431.25	340.32	787.94	n/a
11/12/87		n/a	1084.08	495.88	880.79	534.97	443.22	832.51	779.54

Table 1C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	177	185	213	214	215	217	194	216
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
11/13/87		n/a	1084.08	493.99	880.79	511.80	440.89	831.57	n/a
11/14/87		n/a	1084.08	498.23	880.79	477.44	445.99	827.92	n/a
11/15/87		n/a	1084.08	499.17	880.79	457.67	442.48	822.96	n/a
11/16/87		n/a	1084.08	496.83	880.79	435.36	437.91	469.34	n/a
11/17/87		n/a	1084.08	493.99	880.79	488.76	464.18	853.42	n/a
11/18/87		n/a	1084.08	493.99	880.79	488.76	464.18	853.42	n/a
11/19/87		n/a	1084.08	499.17	880.79	477.16	473.85	863.67	713.72
11/20/87		n/a	1084.08	498.70	880.79	453.31	467.71	857.82	682.99
11/21/87		n/a	1084.08	497.76	880.79	431.94	463.10	954.16	662.98
11/22/87		n/a	1084.08	495.41	467.21	413.36	459.67	949.95	642.69
11/23/87		n/a	1084.08	492.60	880.79	[illegible]	[illegible]	845.93	626.44
11/24/87		n/a	1084.05	495.86	398.49	415.76	460.80	851.55	n/a
11/25/87		n/a	1084.08	494.94	394.19	389.31	457.25	849.83	n/a
11/26/87		n/a	1084.08	493.51	392.66	376.53	453.75	846.56	n/a
11/27/87		n/a	1084.08	491.60	391.31	378.28	455.22	851.29	n/a
11/28/87		n/a	1084.08	489.10	398.16	363.40	451.65	852.93	n/a
11/29/87		n/a	1084.08	485.27	393.40	351.09	448.47	852.93	n/a
11/30/87		n/a	1084.08	482.30	394.58	340.59	445.52	852.81	n/a
12/01/87		n/a	1084.08	482.80	395.37	334.37	443.70	853.92	n/a
12/02/87		n/a	1084.06	482.80	393.79	320.12	442.12	853.79	n/a
12/03/87		n/a	1084.08	481.80	388.59	327.43	441.01	852.19	n/a
12/04/87		n/a	1084.08	483.30	385.74	326.34	440.89	850.33	n/a
12/05/87		n/a	1084.08	495.41	389.84	312.89	436.52	834.24	n/a
12/06/87		n/a	1084.08	496.35	388.19	311.74	434.87	833.71	n/a
12/07/87		n/a	1084.08	496.83	386.97	314.57	433.21	832.38	n/a
12/08/87		n/a	1084.08	494.94	384.51	307.64	431.66	870.67	n/a
12/09/87		n/a	1084.08	492.08	382.85	302.87	430.24	828.60	n/a
12/10/87		n/a	1084.08	491.60	382.85	300.65	426.38	828.66	n/a
12/11/87		n/a	1084.08	490.64	383.66	[illegible]	424.77	828.73	n/a
12/12/87		n/a	1084.08	261.48	396.93	[illegible]	[illegible]	[illegible]	n/a
12/13/87		n/a	1084.08	504.69	410.53	[illegible]	428.71	812.31	n/a

Table 1C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	177	185	213	214	215	217	194	216
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
12/14/87		n/a	1084.08	507.86	420.20	295.52	424.77	817.48	n/a
12/15/87		n/a	1084.08	508.31	424.02	294.28	423.60	820.45	n/a
12/16/87		n/a	1084.08	509.65	427.10	291.13	422.46	822.27	n/a
12/17/87		n/a	1084.08	515.38	432.80	294.28	422.59	824.90	n/a
12/18/87		n/a	1084.08	520.99	434.77	294.28	429.83	809.98	n/a
12/19/87		n/a	1084.08	522.69	436.41	291.76	428.64	811.15	n/a
12/20/87		n/a	1084.08	523.95	436.41	289.85	427.58	811.58	n/a
12/21/87		n/a	1084.08	527.38	438.67	290.49	427.05	812.60	n/a
12/22/87		n/a	1084.08	529.78	440.28	291.13	426.25	812.74	n/a
12/23/87		n/a	1084.08	533.05	442.82	291.76	425.44	813.03	n/a
12/24/87		n/a	1084.08	535.47	444.71	293.02	424.77	812.47	n/a
12/25/87		n/a	1084.08	537.67	444.71	291.13	423.82	813.67	n/a
12/26/87		n/a	1084.08	540.64	446.58	293.02	423.55	813.18	n/a
12/27/87		n/a	1084.08	541.81	446.58	292.39	422.77	812.56	n/a
12/28/87		n/a	1084.08	544.15	447.29	293.02	422.05	812.16	n/a
12/29/87		n/a	1084.08	545.78	447.51	291.02	421.36	811.29	n/a
12/30/87		n/a	1084.08	547.24	443.74	293.65	420.39	810.71	n/a
12/31/87		n/a	1084.08	544.91	444.82	290.87	418.54	808.78	n/a
01/01/88		n/a	1084.08	548.00	447.51	290.49	417.18	807.77	n/a
01/02/88		n/a	1084.08	549.52	448.74	290.49	416.33	807.33	n/a
01/03/88		n/a	1084.08	540.28	556.95	287.93	421.36	793.32	n/a
01/04/88		n/a	1084.08	541.42	555.07	287.29	420.25	793.32	n/a
01/05/88		n/a	1084.08	542.99	550.86	289.85	420.79	793.01	n/a
01/06/88		n/a	1084.08	544.93	565.24	291.13	419.98	792.54	n/a
01/07/88		n/a	1084.08	547.28	555.45	289.22	414.19	787.45	n/a
01/08/88		n/a	1084.08	546.48	554.50	289.22	413.33	786.98	n/a
01/09/88		n/a	1084.08	549.52	558.64	285.25	404.62	780.31	n/a
01/10/88		n/a	1084.08	548.00	643.17	285.00	408.76	778.99	n/a
01/11/88		n/a	1084.08	543.76	644.86	285.35	405.98	778.32	n/a
01/12/88		n/a	1084.08	549.90	654.65	284.44	404.22	777.66	n/a
01/13/88		n/a	1084.08	551.41	654.88	284.70	402.95	777.66	n/a

Table 1C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	177	185	213	214	215	217	194	216
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
01/14/88		n/a	1084.08	554.04	651.00	287.29	401.87	777.16	n/a
01/15/88		n/a	1084.08	554.41	653.19	284.70	399.24	775.48	n/a
01/16/88		n/a	1084.08	552.54	653.07	284.04	400.17	774.64	n/a
01/17/88		n/a	1084.08	553.66	654.76	283.39	398.93	774.64	n/a
01/18/88		n/a	1084.08	555.15	654.76	284.04	397.83	774.30	n/a

Table 2C

Data Collection Report Datalogger 2

Table 2C Continued

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	8 5000 psi
	Cells:	198	199	192	191	204	176	243	188
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)
06/11/87		-246.21	426.38	n/a	341.81	0.00	490.73	449.45	0.00
08/12/87		-244.14	426.45	n/a	345.20	0.00	494.24	451.36	0.00
08/13/87		-244.14	427.09	167.30	346.81	0.00	494.41	451.28	0.00
08/14/87		-244.14	427.40	-171.72	347.93	0.00	495.30	451.56	0.00
08/15/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/16/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/17/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/18/87		-244.78	427.84	n/a	346.37	0.00	495.72	452.82	0.00
08/19/87		-244.98	427.59	n/a	348.09	0.00	495.57	452.90	0.00
08/20/87		-247.09	429.30	n/a	348.84	0.00	496.31	453.30	0.00
08/21/87		-251.79	428.59	n/a	349.33	0.00	496.69	453.27	0.00
08/22/87		-251.36	428.27	n/a	346.62	0.00	496.10	452.93	0.00
08/23/87		-250.50	428.86	n/a	349.66	0.00	496.97	453.22	0.00
08/24/87		-251.36	429.30	n/a	350.36	0.00	497.52	453.33	0.00
08/25/87		-251.36	429.42	n/a	350.49	0.00	497.22	453.37	0.00
08/26/87		-252.66	429.89	n/a	350.92	0.00	497.63	453.50	0.00
08/27/87		-252.23	429.93	n/a	350.92	0.00	497.88	453.60	0.00
08/28/87		-253.96	429.78	n/a	350.92	0.00	497.85	454.05	0.00
08/29/87		-253.96	430.13	n/a	350.92	0.00	498.07	454.17	0.00
08/30/87		-253.09	429.86	n/a	350.88	0.00	498.03	453.85	0.00
08/31/87		-253.96	429.72	n/a	350.92	0.00	498.03	453.54	0.00
09/01/87		-253.96	430.06	n/a	350.92	0.00	497.61	453.21	0.00
09/02/87		-253.96	430.57	n/a	351.25	0.00	497.89	453.16	0.00
09/03/87		-253.96	431.20	n/a	352.03	0.00	498.57	453.33	0.00
09/04/87		-254.84	431.39	n/a	352.40	0.00	498.55	453.13	0.00

Table 2C Continued

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	8 5000 psi
	Cells:	198	199	192	191	204	176	243	188
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)
09/05/87		-255.28	431.29	n/a	352.19	0.00	498.71	452.84	0.00
09/06/87		-255.28	431.22	n/a	351.97	0.00	498.47	452.56	0.00
09/07/87		-256.60	431.15	n/a	351.90	0.00	498.38	452.40	0.00
09/08/87		-257.04	431.20	n/a	352.03	0.00	498.56	452.57	0.00
09/09/87		-255.22	431.07	n/a	352.14	0.00	495.58	452.69	0.00
09/10/87		-257.93	431.54	n/a	352.75	0.00	495.46	452.87	0.00
09/11/87		-273.59	426.39	n/a	361.42	0.00	511.53	464.65	0.00
09/12/87		-281.93	424.58	n/a	364.92	0.00	515.75	468.62	0.00
09/13/87		-281.93	425.00	n/a	365.04	0.00	515.51	468.41	0.00
09/14/87		-282.64	425.58	n/a	366.00	0.00	515.41	468.78	0.00
09/15/87		-259.38	427.13	n/a	367.71	0.00	515.63	469.48	0.00
09/16/87		-259.71	427.61	n/a	367.85	0.00	514.94	469.02	0.00
09/17/87		-268.83	425.07	n/a	378.30	0.00	519.52	474.16	0.00
09/18/87		-283.93	422.63	n/a	390.02	0.00	523.14	479.53	0.00
09/19/87		-288.24	422.97	n/a	390.23	0.00	522.66	479.13	0.00
09/20/87		-271.64	424.02	n/a	390.68	0.00	522.43	478.82	0.00
09/21/87		-274.48	423.80	n/a	391.24	0.00	521.98	478.49	0.00
09/22/87		-260.07	425.31	n/a	392.13	0.00	521.78	478.32	0.00
09/23/87		-267.44	422.22	n/a	409.88	0.00	539.62	495.54	0.00
09/24/87		-274.96	419.97	n/a	425.91	0.00	553.69	507.85	0.00
09/25/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/26/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/27/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/28/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/29/87		-286.22	423.32	n/a	426.30	0.00	546.12	501.75	0.00
09/30/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/01/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/02/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/03/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/04/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/05/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 2C Continued

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	8 5000 psi
	Cells:	198	199	192	191	204	176	243	188
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)
10/06/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/07/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/08/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/09/87		132.77	639.88	n/a	388.71	0.00	522.90	493.20	0.00
10/10/87		-264.22	424.49	n/a	420.88	0.00	537.90	496.20	0.00
10/11/87		-263.77	425.02	n/a	421.19	0.00	537.84	496.53	0.00
10/12/87		-264.22	424.04	n/a	420.94	0.00	537.14	494.87	0.00
10/13/87		-264.22	423.57	n/a	421.18	0.00	537.39	494.26	0.00
10/14/87		-264.22	423.52	n/a	421.37	0.00	537.44	493.81	0.00
10/15/87		-263.77	426.18	n/a	421.52	0.00	535.89	490.03	0.00
10/16/87		-264.22	429.40	n/a	422.42	0.00	529.86	479.09	0.00
10/17/87		-263.31	428.71	n/a	421.92	0.00	526.80	478.17	0.00
10/18/87		-263.77	428.59	n/a	421.73	0.00	525.72	477.93	0.00
10/19/87		-264.22	427.01	n/a	422.16	0.00	525.70	478.12	0.00
10/20/87		-264.22	429.69	n/a	422.70	0.00	524.81	477.81	0.00
10/21/87		-264.22	430.13	n/a	423.17	0.00	524.61	477.47	0.00
10/22/87		-264.22	430.66	n/a	423.74	0.00	523.94	477.50	0.00
10/23/87		-263.77	428.03	n/a	420.17	0.00	518.85	476.09	0.00
10/24/87		-263.77	424.54	n/a	403.16	0.00	507.89	472.37	0.00
10/25/87		-264.22	425.21	n/a	405.93	0.00	508.54	471.19	0.00
10/26/87		-265.60	425.21	n/a	407.18	0.00	508.44	470.40	0.00
10/27/87		-264.22	424.64	n/a	408.12	0.00	507.58	465.76	0.00
10/28/87		-264.22	425.29	n/a	414.47	0.00	508.66	459.72	0.00
10/29/87		-264.22	422.47	n/a	428.40	0.00	524.76	468.66	0.00
10/30/87		-264.22	408.27	n/a	476.51	0.00	579.57	504.75	0.00
10/31/87		-264.22	409.33	n/a	483.07	0.00	577.27	504.93	0.00
11/01/87		-264.22	411.68	n/a	466.64	0.00	576.98	504.08	0.00
11/02/87		-264.68	412.97	n/a	486.10	0.00	576.24	502.98	0.00
11/03/87		-264.68	412.91	n/a	484.51	0.00	575.33	502.26	0.00
11/04/87		-265.60	411.94	n/a	464.94	0.00	575.60	501.87	0.00
11/05/87		-266.06	411.42	n/a	487.82	0.00	574.84	501.73	0.00

Table 2C Continued

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	8 5000 psi
	Cells:	198	199	192	191	204	176	243	188
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)
11/06/87		-271.17	411.52	n/a	491.28	0.00	573.87	501.59	0.00
11/07/87		-511.93	423.20	n/a	521.84	0.00	461.57	554.38	0.00
11/08/87		n/a	427.51	n/a	538.89	0.00	389.52	575.92	0.00
11/09/87		n/a	421.81	n/a	538.82	0.00	387.25	575.94	0.00
11/10/87		n/a	414.63	n/a	534.18	0.00	389.84	575.98	0.00
11/11/87		n/a	409.99	n/a	531.92	0.00	392.19	577.13	0.00
11/12/87		n/a	401.49	n/a	516.63	0.00	397.00	549.09	0.00
11/13/87		n/a	402.50	n/a	493.01	0.00	379.55	504.37	0.00
11/14/87		n/a	401.57	n/a	483.56	0.00	377.92	508.12	0.00
11/15/87		n/a	405.54	n/a	483.90	0.00	380.71	512.54	0.00
11/16/87		n/a	406.30	n/a	477.40	0.00	383.08	513.84	0.00
11/17/87		n/a	408.38	n/a	493.83	0.00	382.85	510.76	0.00
11/18/87		n/a	404.24	n/a	510.18	0.00	378.41	508.26	0.00
11/19/87		n/a	403.48	n/a	519.62	0.00	377.10	515.69	0.00
11/20/87		n/a	405.35	n/a	520.79	0.00	378.40	519.29	0.00
11/21/87		n/a	406.43	n/a	515.66	0.00	379.74	518.06	0.00
11/22/87		n/a	405.81	n/a	510.19	0.00	379.29	516.61	0.00
11/23/87		n/a	404.44	n/a	511.78	0.00	377.88	518.17	0.00
11/24/87		n/a	408.33	n/a	516.74	0.00	381.78	523.05	0.00
11/25/87		n/a	409.42	n/a	512.40	0.00	382.97	521.75	0.00
11/26/87		n/a	410.03	n/a	512.41	0.00	383.48	521.70	0.00
11/27/87		n/a	409.96	n/a	517.62	0.00	383.84	521.65	0.00
11/28/87		n/a	408.51	n/a	520.82	0.00	382.80	519.50	0.00
11/29/87		n/a	404.99	n/a	520.43	0.00	379.69	518.25	0.00
11/30/87		n/a	402.86	n/a	523.11	0.00	377.88	516.99	0.00
12/01/87		n/a	403.56	n/a	523.99	0.00	379.02	517.02	0.00
12/02/87		n/a	404.08	n/a	522.95	0.00	379.51	517.48	0.00
12/03/87		n/a	404.34	n/a	520.60	0.00	379.98	517.90	0.00
12/04/87		n/a	405.74	n/a	519.10	0.00	381.16	514.79	0.00
12/05/87		n/a	407.08	n/a	519.27	0.00	382.12	512.09	0.00
12/06/87		n/a	408.81	n/a	519.12	0.00	383.82	512.35	0.00

Table 2C Continued

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	8 5000 psi
	Cells:	198	199	192	191	204	176	243	188
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)
12/07/87		n/a	409.55	n/a	518.79	0.00	384.81	512.08	0.00
12/08/87		n/a	407.28	n/a	517.50	0.00	382.68	511.00	0.00
12/09/87		n/a	403.90	n/a	517.01	0.00	379.56	509.52	0.00
12/10/87		n/a	404.23	n/a	518.82	0.00	380.02	508.57	0.00
12/11/87		n/a	404.26	n/a	518.80	0.00	380.06	508.58	0.00
12/12/87		n/a	402.39	n/a	514.83	0.00	377.63	501.22	0.00
12/13/87		n/a	403.48	n/a	522.55	0.00	378.52	500.57	0.00
12/14/87		n/a	407.38	n/a	530.69	0.00	382.41	502.06	0.00
12/15/87		n/a	408.51	n/a	536.71	0.00	383.75	503.95	0.00
12/16/87		n/a	403.33	n/a	540.17	0.00	379.29	504.61	0.00
12/17/87		n/a	406.87	n/a	544.09	0.00	382.70	505.56	0.00
12/18/87		n/a	409.30	n/a	537.30	0.00	384.62	510.10	0.00
12/19/87		n/a	407.10	n/a	537.73	0.00	382.29	512.04	0.00
12/20/87		n/a	406.79	n/a	540.31	0.00	382.02	513.56	0.00
12/21/87		n/a	404.34	n/a	541.58	0.00	380.03	514.47	0.00
12/22/87		n/a	405.58	n/a	543.05	0.00	381.75	515.79	0.00
12/23/87		n/a	406.36	n/a	544.17	0.00	382.75	516.85	0.00
12/24/87		n/a	408.66	n/a	545.54	0.00	385.07	518.06	0.00
12/25/87		n/a	407.20	n/a	546.22	0.00	384.37	518.62	0.00
12/26/87		n/a	408.61	n/a	547.08	0.00	386.06	519.35	0.00
12/27/87		n/a	408.69	n/a	547.34	0.00	386.56	519.87	0.00
12/28/87		n/a	409.93	n/a	547.80	0.00	387.89	520.45	0.00
12/29/87		n/a	409.09	n/a	547.30	0.00	387.18	520.70	0.00
12/30/87		n/a	410.92	n/a	547.42	0.00	388.84	521.08	0.00
12/31/87		n/a	407.77	n/a	547.04	0.00	386.75	520.90	0.00
01/01/88		n/a	405.69	n/a	546.20	0.00	384.57	520.39	0.00
01/02/88		n/a	407.61	n/a	546.41	0.00	386.66	520.60	0.00
01/03/88		n/a	408.58	n/a	546.77	0.00	[illegible]	520.68	0.00
01/04/88		n/a	406.92	n/a	536.03	0.00	383.94	522.51	0.00
01/05/88		n/a	405.48	n/a	531.31	0.00	380.82	523.56	0.00
01/06/88		n/a	407.49	n/a	531.21	0.00	382.63	524.07	0.00

Table 2C Continued

Date	Channels:	1 5000 psi	2 5000 psi	3 5000 psi	4 5000 psi	5 5000 psi	6 5000 psi	7 5000 psi	8 5000 psi
	Cells:	198	199	192	191	204	176	243	188
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)
01/07/88		n/a	409.78	n/a	530.88	0.00	384.71	524.33	0.00
01/08/88		n/a	406.79	n/a	535.04	0.00	382.78	520.13	0.00
01/09/88		n/a	408.10	n/a	531.53	0.00	383.16	520.47	0.00
01/10/88		n/a	407.38	n/a	531.82	0.00	382.78	520.72	0.00
01/11/88		n/a	406.43	n/a	532.85	0.00	382.34	520.69	0.00
01/12/88		n/a	404.60	n/a	533.75	0.00	380.70	520.07	0.00
01/13/88		n/a	409.86	n/a	536.33	0.00	384.45	519.94	0.00
01/14/88		n/a	408.84	n/a	536.94	0.00	384.04	520.04	0.00
01/15/88		n/a	405.33	n/a	533.03	0.00	382.12	520.19	0.00
01/16/88		n/a	405.09	n/a	533.52	0.00	381.43	520.26	0.00
01/17/88		n/a	406.51	n/a	534.64	0.00	382.58	520.82	0.00
01/18/88		n/a	408.07	n/a	535.76	0.00	383.82	521.40	0.00

Table 2C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	201	206	180	184	195	202	187	178
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
08/11/87		405.22	440.51	231.63	493.43	309.77	410.00	n/a	226.17
08/12/87		404.33	438.49	231.79	493.87	310.46	409.18	n/a	226.50
08/13/87		404.30	440.03	231.90	494.47	311.29	413.14	n/a	226.50
08/14/87		404.03	440.91	231.92	495.37	312.04	413.71	n/a	226.71
08/15/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/16/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/17/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/18/87		402.44	440.09	231.87	495.74	315.81	407.20	n/a	227.48
08/19/87		402.37	439.59	231.81	495.60	316.09	407.56	n/a	227.81
08/20/87		402.98	440.20	232.35	497.26	316.74	407.86	n/a	228.55
08/21/87		402.82	439.84	232.45	497.45	317.51	406.65	n/a	228.76
08/22/87		402.15	438.61	232.18	495.92	317.70	404.91	n/a	228.31
08/23/87		402.71	439.94	232.77	497.91	318.65	405.24	n/a	229.13
08/24/87		402.94	440.47	233.10	498.83	319.56	405.75	n/a	229.50
08/25/87		403.03	440.51	233.05	498.80	320.17	405.66	n/a	229.65
08/26/87		403.14	440.73	233.29	499.74	320.65	406.14	n/a	230.08
08/27/87		402.82	440.32	233.15	499.37	321.08	405.97	n/a	230.16
08/28/87		402.77	440.31	233.18	499.77	322.10	405.75	n/a	230.71
08/29/87		402.44	439.99	233.29	499.93	322.61	405.12	n/a	230.80
08/30/87		401.70	439.29	233.03	499.15	323.26	404.76	n/a	230.51
08/31/87		400.86	438.68	232.98	498.91	324.04	404.84	n/a	230.24
09/01/87		400.63	438.96	233.15	499.15	324.92	406.37	n/a	230.37
09/02/87		400.81	438.75	233.52	500.55	325.51	407.22	n/a	230.69
09/03/87		401.54	439.50	234.03	502.10	326.28	408.22	n/a	231.16
09/04/87		401.70	439.72	234.19	502.10	326.83	408.62	n/a	231.31

Table 2C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	201	206	180	184	195	202	187	178
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
09/05/87		401.29	439.48	233.95	501.35	327.56	408.32	n/a	231.10
09/06/87		400.79	439.07	233.64	500.47	327.91	407.88	n/a	230.88
09/07/87		400.08	439.09	233.55	500.15	328.64	407.81	n/a	230.69
09/08/87		400.02	439.62	233.72	500.31	329.27	408.01	n/a	230.64
09/09/87		399.78	440.38	233.53	500.07	330.48	407.78	n/a	230.67
09/10/87		400.43	441.45	234.00	501.38	330.71	408.33	n/a	230.93
09/11/87		400.43	443.50	232.15	496.46	331.10	405.43	n/a	230.89
09/12/87		399.03	441.04	231.14	493.70	331.42	405.08	n/a	230.14
09/13/87		398.16	439.58	230.93	493.29	332.02	405.41	n/a	229.73
09/14/87		398.80	440.97	231.16	494.53	332.56	406.79	n/a	230.03
09/15/87		399.58	441.85	231.71	496.16	333.74	411.14	n/a	230.37
09/16/87		399.56	442.21	231.93	496.25	334.08	408.13	n/a	229.98
09/17/87		409.18	484.46	231.11	493.26	334.22	417.10	n/a	227.63
09/18/87		414.46	515.52	230.36	490.50	334.39	428.02	n/a	224.71
09/19/87		413.12	512.44	230.42	490.83	334.42	428.63	n/a	224.61
09/20/87		413.27	511.43	230.89	491.47	335.34	432.30	n/a	224.91
09/21/87		413.51	511.88	230.82	491.36	335.78	432.43	n/a	224.90
09/22/87		413.48	510.67	231.49	492.71	336.86	430.03	n/a	224.99
09/23/87		444.91	584.71	231.26	494.17	336.98	447.59	n/a	232.70
09/24/87		468.08	635.30	231.63	497.89	337.02	464.13	n/a	238.32
09/25/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/26/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/27/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/28/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/29/87		460.70	623.72	230.94	502.15	339.47	479.46	n/a	234.73
09/30/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/01/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/02/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/03/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/04/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/05/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 2C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	201	206	180	184	195	202	187	178
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
10/06/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/07/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/08/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/09/87		476.19	n/a	233.28	472.40	315.90	461.49	-136.01	202.55
10/10/87		524.27	n/a	245.83	512.02	342.29	474.86	n/a	228.15
10/11/87		522.53	n/a	245.36	512.43	342.58	473.22	n/a	227.50
10/12/87		519.50	n/a	244.57	512.38	342.98	471.38	n/a	226.50
10/13/87		517.77	n/a	244.33	512.40	343.20	469.87	n/a	225.98
10/14/87		517.30	n/a	243.92	512.63	343.62	468.30	n/a	225.32
10/15/87		487.25	304.23	239.94	509.10	343.81	456.98	n/a	225.46
10/16/87		413.93	546.44	231.51	499.45	343.81	432.18	n/a	223.24
10/17/87		413.16	545.88	230.60	495.10	344.32	432.19	-559.04	221.45
10/18/87		412.26	545.13	230.17	493.81	344.42	433.73	8.56	220.55
10/19/87		412.69	545.49	230.51	494.72	344.53	434.06	151.43	220.72
10/20/87		413.46	545.98	231.23	496.17	344.58	435.49	271.45	220.91
10/21/87		413.87	546.75	231.28	496.91	344.75	436.18	294.10	220.85
10/22/87		414.19	547.14	231.18	497.53	345.06	438.33	294.70	220.98
10/23/87		414.30	554.62	231.39	493.24	345.45	432.70	296.74	223.69
10/24/87		411.27	547.85	231.12	479.41	345.64	423.78	296.00	222.65
10/25/87		412.52	550.31	231.40	479.35	345.80	429.19	294.94	221.73
10/26/87		412.37	550.69	231.44	478.45	346.03	430.81	293.96	220.96
10/27/87		408.49	540.73	230.61	475.20	346.19	427.16	293.03	218.69
10/28/87		403.81	526.83	230.58	474.37	346.24	426.06	293.52	217.21
10/29/87		475.01	601.18	230.49	467.12	346.43	438.87	291.54	215.50
10/30/87		657.71	797.07	229.67	430.39	346.79	476.53	286.25	209.20
10/31/87		664.44	807.09	231.33	431.67	346.85	480.85	287.56	211.13
11/01/87		666.19	810.59	233.01	435.84	346.85	484.62	289.24	212.97
11/02/87		663.29	808.09	234.02	437.77	347.05	485.76	289.74	213.45
11/03/87		661.12	805.83	233.69	435.12	347.45	485.40	288.36	213.10
11/04/87		660.42	806.35	232.56	431.53	347.50	487.01	286.58	212.34
11/05/87		660.96	808.16	232.07	431.29	347.79	491.51	286.06	212.21

Table 2C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	201	206	180	184	195	202	187	178
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
11/06/87		663.21	811.18	232.93	435.90	348.38	497.25	287.31	213.47
11/07/87		564.86	520.04	249.26	1072.07	349.34	260.23	298.28	292.43
11/08/87		434.68	n/a	253.22	1161.45	349.81	n/a	303.09	319.22
11/09/87		422.94	n/a	254.67	1161.45	349.86	n/a	304.09	322.98
11/10/87		414.68	n/a	253.86	1161.45	350.14	n/a	305.42	327.74
11/11/87		408.92	n/a	254.14	1161.45	350.63	n/a	306.24	331.44
11/12/87		534.63	n/a	243.58	1161.45	351.37	n/a	293.39	229.79
11/13/87		610.51	n/a	229.02	1161.45	353.20	n/a	276.76	n/a
11/14/87		584.93	n/a	229.16	1161.45	354.43	n/a	277.39	n/a
11/15/87		558.61	n/a	227.96	1161.45	354.71	n/a	275.82	n/a
11/16/87		531.10	n/a	228.73	1161.45	355.06	n/a	276.52	n/a
11/17/87		545.04	n/a	232.23	1161.45	355.23	n/a	274.01	n/a
11/18/87		523.42	n/a	n/a	1161.45	349.83	n/a	263.41	n/a
11/19/87		526.83	n/a	n/a	1161.45	349.83	n/a	260.91	n/a
11/20/87		501.85	n/a	n/a	1161.45	350.23	n/a	260.74	n/a
11/21/87		482.89	n/a	50.17	1161.45	350.23	n/a	260.38	n/a
11/22/87		466.03	n/a	49.84	1161.45	350.42	n/a	259.28	n/a
11/23/87		466.41	n/a	227.49	1161.45	350.42	n/a	258.31	n/a
11/24/87		460.56	n/a	192.19	1161.45	350.42	n/a	260.11	n/a
11/25/87		447.21	n/a	162.44	1161.45	350.97	n/a	259.85	n/a
11/26/87		446.65	n/a	229.02	1161.45	351.13	n/a	260.45	n/a
11/27/87		443.60	n/a	229.84	1161.45	351.40	n/a	260.54	n/a
11/28/87		440.33	n/a	229.71	1161.45	351.60	n/a	260.11	n/a
11/29/87		433.70	n/a	228.42	1161.45	352.15	n/a	258.17	n/a
11/30/87		431.36	n/a	228.67	1161.45	352.18	n/a	257.87	n/a
12/01/87		428.24	n/a	228.04	1161.45	352.18	n/a	257.56	n/a
12/02/87		423.27	n/a	227.57	1161.45	352.22	n/a	257.43	n/a
12/03/87		418.44	n/a	227.21	1161.45	352.18	n/a	256.89	n/a
12/04/87		403.54	n/a	227.71	1161.45	352.18	n/a	257.29	n/a
12/05/87		400.91	n/a	228.04	1161.45	352.18	n/a	257.90	n/a
12/06/87		399.69	n/a	228.64	1161.45	352.18	n/a	258.64	n/a

Table 2C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	201	206	180	184	195	202	187	178
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
12/07/87		397.90	n/a	228.83	1161.45	352.18	n/a	259.18	n/a
12/08/87		394.26	n/a	227.93	1161.45	352.18	n/a	257.77	n/a
12/09/87		391.92	n/a	227.32	1161.45	352.18	n/a	256.31	n/a
12/10/87		392.29	n/a	227.03	1161.45	352.21	n/a	256.49	n/a
12/11/87		381.82	n/a	227.87	1161.45	359.86	n/a	256.63	n/a
12/12/87		389.93	n/a	230.06	1161.45	362.90	n/a	259.16	n/a
12/13/87		398.77	n/a	232.55	1161.45	363.17	n/a	262.72	n/a
12/14/87		404.19	n/a	234.01	1161.45	363.47	n/a	264.89	n/a
12/15/87		404.86	n/a	232.90	1161.45	363.54	n/a	263.30	n/a
12/16/87		407.80	n/a	234.15	1161.45	363.65	n/a	265.51	n/a
12/17/87		399.95	n/a	235.00	1161.45	364.02	n/a	267.01	n/a
12/18/87		396.79	n/a	234.69	1161.45	364.06	n/a	266.95	n/a
12/19/87		399.23	n/a	234.89	1161.45	364.06	n/a	267.15	n/a
12/20/87		397.69	n/a	234.11	1161.45	364.06	n/a	266.20	n/a
12/21/87		397.93	n/a	234.59	1161.45	364.06	n/a	267.27	n/a
12/22/87		397.71	n/a	234.92	1161.45	364.06	n/a	267.91	n/a
12/23/87		398.35	n/a	235.84	1161.45	364.06	n/a	269.36	n/a
12/24/87		397.95	n/a	235.58	1161.45	364.25	n/a	269.12	n/a
12/25/87		397.87	n/a	235.92	1161.45	364.25	n/a	269.86	n/a
12/26/87		397.69	n/a	236.17	1161.45	364.31	n/a	270.17	n/a
12/27/87		397.47	n/a	236.56	1161.45	364.38	n/a	270.61	n/a
12/28/87		396.67	n/a	236.40	1161.45	364.36	n/a	270.29	n/a
12/29/87		396.87	n/a	237.00	1161.45	364.43	n/a	271.37	n/a
12/30/87		395.87	n/a	236.17	1161.45	364.52	n/a	269.93	n/a
12/31/87		393.34	n/a	234.92	1161.45	364.61	n/a	268.21	n/a
01/01/88		393.74	n/a	235.63	1161.45	364.56	n/a	269.34	n/a
01/02/88		394.30	n/a	236.09	1161.45	364.59	n/a	269.82	n/a
01/03/88		390.17	n/a	235.66	1161.45	364.61	n/a	268.17	n/a
01/04/88		388.69	n/a	235.32	1161.45	364.61	n/a	267.43	n/a
01/05/88		387.44	n/a	235.89	1161.45	364.63	n/a	268.62	n/a
01/06/88		390.41	n/a	236.69	1161.45	364.63	n/a	269.62	n/a

Table 2C Continued

Date	Channels:	9 5000 psi	10 5000 psi	11 5000 psi	12 5000 psi	13 5000 psi	14 5000 psi	15 5000 psi	16 5000 psi
	Cells:	201	206	180	184	195	202	187	178
	Values in:	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)	(Psi)
01/07/88		391.05	n/a	236.97	1161.45	364.72	n/a	269.84	n/a
01/08/88		389.35	n/a	236.05	1161.45	364.77	n/a	268.45	n/a
01/09/88		390.41	n/a	236.14	1161.45	364.84	n/a	269.03	n/a
01/10/88		391.77	n/a	236.27	1161.45	364.77	n/a	269.17	n/a
01/11/88		392.14	n/a	235.97	1161.45	364.79	n/a	267.91	n/a
01/12/88		391.93	n/a	235.37	1161.45	364.88	n/a	266.93	n/a
01/13/88		394.03	n/a	236.92	1161.45	364.91	n/a	269.34	n/a
01/14/88		394.64	n/a	237.15	1161.45	365.06	n/a	269.46	n/a
01/15/88		393.18	n/a	235.93	1161.45	365.11	n/a	267.31	n/a
01/16/88		392.91	n/a	235.42	1161.45	365.04	n/a	266.64	n/a
01/17/88		393.94	n/a	235.86	1161.45	365.06	n/a	267.29	n/a
01/18/88		394.84	n/a	236.46	1161.45	365.11	n/a	268.31	n/a

Table 3C

Data Collection Report Datalogger 3

Date	Channels:	1 TP Cell	2 TP Cell	3 TP Cell	4 TP Cell	5 Piezo1	6 Piezo2	7 Piezo3	8 Therm1	9 Therm2
	Cells:	181	188	219	221	207	207	208	181	188
	Values in:	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)	(Volts)	(Volts)	(Volts)	(Volts)
07/03/87		1005.21	512.00	982.11	746.68	2.43	6.91	15.28	512.00	512.00
07/04/87		1005.21	512.00	781.40	746.68	6.25	12.88	27.57	512.00	512.00
07/05/87		1005.21	512.00	764.87	746.68	7.00	19.31	78.38	512.00	512.00
07/06/87		1005.21	512.00	753.83	746.66	10.59	26.83	141.04	512.00	512.00
07/07/87		1005.21	512.00	739.40	746.68	17.63	31.54	167.35	512.00	512.00
07/08/87		1005.21	512.00	732.34	746.68	12.13	33.56	179.35	512.00	512.00
07/09/87		1005.21	512.00	725.63	746.68	0.97	21.96	177.99	512.00	512.00
07/10/87		1005.21	512.00	720.39	746.68	0.00	6.32	215.29	512.00	512.00
07/11/87		1005.21	512.00	712.65	746.68	0.00	0.00	283.44	512.00	512.00
07/12/87		1005.21	512.00	714.11	746.68	0.00	0.00	373.53	512.00	512.00
07/13/87		1005.21	512.00	714.30	746.68	0.00	0.00	446.95	512.00	512.00
07/14/87		1005.21	512.00	710.53	746.68	0.00	0.00	454.99	512.00	512.00
07/15/87		1005.21	512.00	714.88	746.68	0.00	0.00	491.53	512.00	512.00
07/16/87		1005.21	512.00	715.80	746.68	0.00	0.00	512.00	512.00	512.00
07/17/87		1005.21	512.00	711.14	746.68	0.00	0.00	512.00	512.00	512.00
07/18/87		1005.21	512.00	714.04	746.68	0.00	0.00	512.00	512.00	512.00
07/19/87		1005.21	512.00	708.55	746.68	0.00	0.00	512.00	512.00	512.00
07/20/87		1005.21	512.00	706.30	746.68	0.00	0.00	512.00	512.00	512.00
07/21/87		1005.21	512.00	713.63	746.68	0.00	0.00	512.00	512.00	512.00
07/22/87		1005.21	512.00	706.47	746.68	0.00	0.00	512.00	512.00	512.00
07/23/87		1005.21	512.00	711.35	746.68	0.00	0.00	512.00	512.00	512.00
07/24/87		1005.21	512.00	710.32	746.68	0.00	0.00	512.00	512.00	512.00
07/25/87		1005.21	512.00	716.88	746.68	0.00	0.00	512.00	512.00	512.00
07/26/87		1005.21	512.00	706.74	746.68	0.00	0.00	512.00	512.00	512.00
07/27/87		1005.21	512.00	715.84	746.68	5.17	7.52	322.00	512.00	512.00

Table 3C Continued

Date	Channels:	1 TP Cell	2 TP Cell	3 TP Cell	4 TP Cell	5 Piezo1	6 Piezo2	7 Piezo3	9 Therm1	10 Therm2
	Cells:	181	188	219	221	207	207	208	181	188
	Values in:	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)	(Volts)	(Volts)	(Volts)	(Volts)
07/28/87		1005.21	512.00	727.68	746.68	148.12	41.20	34.48	512.00	512.00
07/29/87		1005.21	512.00	720.02	746.68	152.15	66.31	58.31	512.00	512.00
07/30/87		1005.21	512.00	712.75	746.68	99.10	38.04	34.71	512.00	512.00
07/31/87		1005.21	512.00	715.42	746.68	103.08	60.98	59.20	512.00	512.00
08/01/87		1005.21	512.00	700.78	746.68	84.77	53.32	52.39	512.00	512.00
08/02/87		1005.21	512.00	693.04	746.68	120.48	51.91	46.05	512.00	512.00
08/03/87		1005.21	512.00	684.91	746.68	105.98	3.25	3.69	512.00	512.00
08/04/87		1005.21	512.00	686.10	746.68	89.21	3.56	3.57	512.00	512.00
08/05/87		1005.21	512.00	718.63	746.68	2.08	0.00	0.00	512.00	512.00
08/06/87		1005.21	512.00	717.42	746.68	0.87	0.00	0.00	512.00	512.00
08/07/87		1005.21	512.00	693.11	746.68	1.40	0.00	0.00	512.00	512.00
08/08/87		1005.21	512.00	718.06	746.68	0.00	0.00	0.00	512.00	512.00
08/09/87		1005.21	512.00	719.56	746.68	0.00	0.00	0.00	512.00	512.00
08/10/87		1005.21	512.00	723.67	746.68	0.00	0.00	0.00	512.00	512.00
08/11/87		1005.21	512.00	694.75	746.68	0.00	0.00	0.00	512.00	512.00
08/12/87		1005.21	512.00	708.50	746.68	0.00	0.00	0.00	512.00	512.00
08/13/87		1005.21	512.00	703.00	746.68	0.00	0.00	0.00	512.00	512.00
08/14/87		1005.21	512.00	685.63	746.68	0.00	0.00	0.00	512.00	512.00
08/15/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/16/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/17/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/18/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/19/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/20/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/21/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/22/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/23/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/24/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/25/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/26/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/27/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 3C Continued

Date	Channels:	1 TP Cell	2 TP Cell	3 TP Cell	4 TP Cell	5 Piezo1	6 Piezo2	7 Piezo3	9 Theral	10 Therm2
	Cells:	181	168	219	221	207	207	208	181	188
	Values in:	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)	(Volts)	(Volts)	(Volts)	(Volts)
08/28/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/29/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/30/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/31/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/01/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/02/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/03/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/04/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/05/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/06/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/07/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/08/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/09/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/10/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/11/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/12/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/13/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/14/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/15/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/16/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/17/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/18/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/19/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/20/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/21/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/22/87		1005.21	0.00	563.83	586.63	99.04	0.09	2.69	512.00	123.63
09/23/87		1005.21	0.00	565.62	546.30	73.00	0.00	2.31	512.00	123.21
09/24/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/25/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/26/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/27/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 3C Continued

Date	Channels:	1 TP Cell	2 TP Cell	3 TP Cell	4 TP Cell	5 Piezo1	6 Piezo2	7 Piezo3	9 Therm1	10 Therm2
	Cells:	181	188	219	221	207	207	208	181	186
	Values in:	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)	(Volts)	(Volts)	(Volts)	(Volts)
09/28/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/29/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/30/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/01/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/02/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/03/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/04/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/05/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/06/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/07/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/08/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/09/87		1005.21	0.00	709.89	746.68	73.67	0.00	2.1[illegible]	512.00	122.71
10/10/87		1005.21	0.00	722.69	746.68	72.49	0.00	2.26	512.00	122.70
10/11/87		1005.21	0.00	725.48	746.68	74.18	0.00	2.27	512.00	122.70
10/12/87		1005.21	0.00	721.12	746.68	73.00	0.00	0.83	512.00	122.70
10/13/87		1005.21	0.00	719.23	746.68	72.60	0.00	0.00	512.00	122.70
10/14/87		1005.21	0.00	718.02	746.68	72.01	0.00	0.00	512.00	122.70
10/15/87		1005.21	0.00	703.67	746.68	70.89	0.00	0.00	512.00	122.70
10/16/87		1005.21	0.00	714.75	746.68	70.15	0.00	0.00	512.00	122.70
10/17/87		1005.21	0.00	698.23	746.68	65.76	0.00	0.00	512.00	122.70
10/18/87		1005.21	0.00	694.21	746.68	60.75	0.00	0.00	512.00	122.70
10/19/87		1005.21	0.00	702.50	746.68	59.01	0.00	0.00	512.00	122.70
10/20/87		1005.21	0.00	726.93	746.68	65.97	0.00	0.00	512.00	122.65
10/21/87		1005.21	0.00	728.66	746.68	66.76	0.00	0.00	512.00	122.66
10/22/87		1005.21	0.00	728.47	746.68	67.18	0.00	0.00	512.00	122.61
10/23/87		1005.21	0.00	727.13	746.68	67.54	0.00	0.00	512.00	122.60
10/24/87		1005.21	0.00	731.42	746.68	67.80	0.00	0.00	512.00	122.60
10/25/87		1005.21	0.00	730.41	746.68	68.07	0.00	0.00	512.00	122.58
10/26/87		1005.21	0.00	734.00	746.68	63.79	0.00	0.00	512.00	122.53
10/27/87		1005.21	0.00	732.16	746.68	57.22	0.00	0.00	512.00	122.50
10/28/87		1005.21	0.00	733.68	746.68	57.15	0.00	0.00	512.00	122.50

Table 3C Continued

Date	Channels:	1 TP Cell	2 TP Cell	3 TP Cell	4 TP Cell	5 Piezo1	6 Piezo2	7 Piezo3	9 Therm1	10 Therm2
	Cells:	181	188	219	221	207	207	208	181	188
	Values in:	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)	(Volts)	(Volts)	(Volts)	(Volts)
10/29/87		1005.21	0.00	733.13	746.68	59.75	0.00	0.00	512.00	122.53
10/30/87		1005.21	0.00	733.81	746.68	64.21	0.00	0.00	512.00	122.48
10/31/87		1005.21	0.00	735.53	746.68	67.47	0.00	0.00	512.00	122.48
11/01/87		1005.21	0.00	729.80	746.68	67.23	0.00	0.00	512.00	122.48
11/02/87		1005.21	0.00	729.92	746.68	67.19	0.00	0.00	512.00	122.44
11/03/87		1005.21	0.00	709.72	746.68	57.66	0.00	0.00	512.00	122.44
11/04/87		1005.21	0.00	683.59	746.68	33.55	0.00	0.00	512.00	122.59
11/05/87		1005.21	0.00	676.89	746.68	29.03	0.00	0.00	512.00	122.45
11/06/87		1005.21	0.00	714.76	746.68	59.42	0.00	0.00	512.00	123.02
11/07/87		1005.21	0.00	728.65	746.68	91.23	0.00	0.00	512.00	123.37
11/08/87		1005.21	0.00	727.63	746.68	85.79	0.00	0.00	512.00	123.49
11/09/87		1005.21	0.00	676.19	746.68	76.03	0.00	0.00	512.00	123.45
11/10/87		1005.21	0.00	659.65	746.68	72.13	0.00	0.00	512.00	123.37
11/11/87		1005.21	0.00	692.39	746.68	42.73	0.00	0.00	512.00	123.32
11/12/87		1005.21	0.00	720.90	746.68	28.09	0.00	0.15	512.00	123.13
11/13/87		1005.21	0.00	722.64	746.68	9.55	0.00	0.00	512.00	122.81
11/14/87		1005.21	0.00	722.10	746.68	8.31	0.00	0.00	512.00	122.39
11/15/87		1005.21	0.00	720.48	746.68	8.03	0.00	0.00	512.00	121.88
11/16/87		1005.21	0.00	719.28	746.68	8.00	0.00	0.00	512.00	120.43
11/17/87		1005.21	0.00	720.30	746.66	7.87	0.00	0.00	512.00	120.03
11/18/87		845.23	0.00	684.51	746.68	8.59	0.04	0.00	512.00	119.75
11/19/87		845.23	0.00	668.08	746.68	8.47	0.00	0.00	512.00	119.39
11/20/87		845.23	0.00	666.58	746.68	8.20	0.00	0.00	512.00	119.34
11/21/87		845.23	0.00	660.91	746.68	7.98	0.00	0.00	512.00	118.91
11/22/87		845.23	0.00	666.64	746.69	7.96	0.00	0.00	512.00	118.47
11/23/87		845.23	0.00	665.68	746.66	7.75	0.00	0.00	512.00	118.06
11/24/87		845.23	0.00	663.94	746.68	7.66	0.00	0.00	512.00	117.62
11/25/87		845.23	0.00	659.66	746.68	7.58	0.00	0.00	512.00	117.20
11/26/87		845.23	0.00	654.17	746.68	7.38	0.00	0.00	512.00	116.77
11/27/87		845.23	0.00	714.57	746.68	7.34	0.00	0.00	512.00	116.35
11/28/87		845.23	0.00	711.75	746.68	7.34	0.00	0.00	512.00	115.93

Table 3C Continued

Date	Channels:	1 TP Cell	2 TP Cell	3 TP Cell	4 TP Cell	5 Piezo1	6 Piezo2	7 Piezo3	9 Theral	10 Thera2
	Cells:	181	188	219	221	207	207	208	181	188
	Values in:	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)	(Volts)	(Volts)	(Volts)	(Volts)
11/29/87		845.23	0.00	710.99	746.68	7.20	0.00	0.00	512.00	115.51
11/30/87		845.23	0.00	709.68	746.68	7.12	0.00	0.00	512.00	115.09
12/01/87		845.23	0.00	709.12	746.68	7.09	0.00	0.00	512.00	114.72
12/02/87		845.23	0.00	707.01	746.68	6.96	0.00	0.00	512.00	114.36
12/03/87		845.23	0.00	706.34	746.68	6.83	0.00	0.00	512.00	114.11
12/04/87		845.23	0.00	712.69	746.68	6.90	0.00	0.00	512.00	113.77
12/05/87		845.23	0.00	719.10	746.68	7.03	0.00	0.00	512.00	113.51
12/06/87		845.23	0.00	690.66	746.68	7.03	0.00	0.00	512.00	113.28
12/07/87		845.23	0.00	706.45	746.68	7.00	0.00	0.00	512.00	113.10
12/08/87		845.23	0.00	669.58	746.68	6.96	0.00	0.00	512.00	112.83
12/09/87		845.23	0.00	702.22	746.68	6.39	0.00	0.00	512.00	112.61
12/10/87		1005.21	0.00	589.16	284.45	512.00	0.00	0.00	512.00	111.86
12/11/87		1005.21	0.00	604.05	291.01	512.00	0.00	0.00	512.00	111.68
12/12/87		1005.21	0.00	613.18	298.19	512.00	0.00	0.00	512.00	111.49
12/13/87		1005.21	0.00	650.73	302.12	512.00	0.00	0.00	512.00	111.36
12/14/87		1005.21	0.00	692.39	301.53	512.00	0.00	0.00	512.00	111.26
12/15/87		1005.21	0.00	685.24	305.62	512.00	0.00	0.00	512.00	111.21
12/16/87		1005.21	0.00	679.19	305.77	512.00	0.00	0.00	512.00	111.22
12/17/87		1005.21	0.00	679.75	305.18	512.00	0.00	0.00	512.00	111.27
12/18/87		1005.21	0.00	674.46	306.01	512.00	0.00	0.00	512.00	111.25
12/19/87		1005.21	0.00	692.63	305.13	512.00	0.00	0.00	512.00	111.33
12/20/87		1005.21	0.00	689.87	305.78	512.00	0.00	0.00	512.00	111.42
12/21/87		1005.21	0.00	693.49	307.97	512.00	0.00	0.00	512.00	111.57
12/22/87		1005.21	0.00	682.58	310.02	512.00	0.00	0.00	512.00	111.61
12/23/87		1005.21	0.00	684.06	309.62	512.00	0.00	0.00	512.00	111.64
12/24/87		1005.21	0.00	671.83	310.44	512.00	0.00	0.00	512.00	111.71
12/25/87		1005.21	0.00	683.67	310.60	512.00	0.00	0.00	512.00	111.77
12/26/87		1005.21	0.00	668.78	311.19	512.00	0.00	0.00	512.00	111.37
12/27/87		1005.21	0.00	684.17	310.30	512.00	0.00	0.00	512.00	111.91
12/28/87		1005.21	0.00	692.92	311.57	512.00	0.00	0.00	512.00	112.00
12/29/87		1005.21	0.00	683.41	309.93	512.00	0.00	0.00	512.00	112.02

Table 3C Continued

Date	Channels:	1 TP Cell	2 TP Cell	3 TP Cell	4 TP Cell	5 Piezo1	6 Piezo2	7 Piezo3	9 Therm1	10 Therm2
	Cells:	181	188	219	221	207	207	208	181	188
	Values in:	(Psi)	(Volts)	(Psi)	(Psi)	(Volts)	(Volts)	(Volts)	(Volts)	(Volts)
12/30/87		1005.21	0.00	689.53	307.81	512.00	0.00	0.00	512.00	111.94
12/31/87		1005.21	15.00	147.03	308.59	512.00	0.00	0.00	512.00	111.81
01/01/88		1005.21	31.52	435.89	308.62	512.00	0.00	0.00	512.00	111.72
01/02/88		1005.21	0.00	697.40	310.06	512.00	0.00	0.00	512.00	111.83
01/03/88		1005.21	0.00	697.11	309.25	512.00	0.00	0.00	512.00	111.95
01/04/88		1005.21	0.00	683.59	305.01	512.00	0.00	0.00	512.00	112.16
01/05/88		1005.21	0.00	695.56	304.28	512.00	0.00	0.00	512.00	112.22
01/06/88		1005.21	0.00	675.79	305.55	512.00	0.00	0.00	512.00	112.26
01/07/88		1005.21	0.00	691.62	307.37	512.00	0.00	0.00	512.00	112.26
01/08/88		1005.21	0.00	699.11	304.58	512.00	0.00	0.00	512.00	112.25
01/09/88		1005.21	0.00	696.97	305.03	512.00	0.00	0.00	512.00	112.24
01/10/88		1005.21	0.00	637.51	305.55	512.00	0.00	0.00	512.00	112.31
01/11/88		1005.21	0.00	697.73	305.39	512.00	0.00	0.00	512.00	112.15
01/12/88		1005.21	0.00	705.99	304.61	512.00	0.00	0.00	512.00	111.88
01/13/88		1005.21	0.00	689.20	307.86	512.00	0.00	0.00	512.00	112.10
01/14/88		1005.21	0.00	682.38	307.73	512.00	0.00	0.00	512.00	112.32
01/15/88		1005.21	0.00	692.42	305.90	512.00	0.00	0.00	512.00	112.33
01/16/88		1005.21	0.00	714.92	305.70	512.00	0.00	0.00	512.00	112.32
01/17/88		1005.21	0.00	691.14	307.14	512.00	0.00	0.00	512.00	112.36
01/18/88		1005.21	0.00	706.04	308.44	512.00	0.00	0.00	512.00	112.12

Table 3C Continued

Date	Channels:	10 Therm3	11 Therm4	13 Pot184	17 Pot185	14 Pot186	21 Pot187	15 Pot188	25 Pot189	16 Pot190
	Cells:	219	221	184	185	186	187	188	189	190
	Values in:	(Volts)	(Volts)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)
07/03/87		4.56	3.59	3.04	3.00	3.02	3.08	3.01	3.10	4.84
07/04/87		4.56	3.59	3.04	3.00	3.02	3.08	3.01	3.10	4.83
07/05/87		4.56	3.59	3.04	3.00	3.02	3.08	3.01	3.10	4.81
07/06/87		4.56	3.59	3.04	3.00	3.02	3.08	3.01	3.10	4.81
07/07/87		4.55	3.59	3.04	3.00	3.02	3.08	3.01	3.10	4.82
07/08/87		4.55	3.59	3.04	3.00	3.02	3.08	3.01	3.10	4.84
07/09/87		4.55	3.59	3.04	3.00	3.02	3.08	3.01	3.10	4.89
07/10/87		4.55	3.59	3.04	3.00	3.02	3.08	3.01	3.10	4.95
07/11/87		4.55	3.58	3.04	3.00	3.02	3.08	3.01	3.10	5.00
07/12/87		4.55	3.58	3.04	3.00	3.02	3.08	3.01	3.10	4.96
07/13/87		4.55	3.58	3.04	3.00	3.02	3.08	3.01	3.10	4.92
07/14/87		4.55	3.58	3.04	3.00	3.02	3.08	3.01	3.10	4.90
07/15/87		4.55	3.58	3.04	3.00	3.02	3.08	3.01	3.10	4.94
07/16/87		4.55	3.58	3.04	3.00	3.02	3.08	3.01	3.10	4.94
07/17/87		4.55	3.58	3.04	3.00	3.02	3.08	3.01	3.10	4.94
07/18/87		4.55	3.58	3.04	3.00	3.02	3.08	3.01	3.10	5.02
07/19/87		4.55	3.58	3.04	3.00	3.02	3.08	3.01	3.10	5.11
07/20/87		4.55	3.58	3.04	3.00	3.02	3.08	3.01	3.10	5.14
07/21/87		4.54	3.58	3.04	3.00	3.02	3.08	3.01	3.10	5.23
07/22/87		4.54	3.58	3.04	3.00	3.02	3.08	3.01	3.10	5.22
07/23/87		4.54	3.58	3.04	3.00	3.02	3.08	3.01	3.10	5.24
07/24/87		4.54	3.58	3.04	3.00	3.02	3.08	3.01	3.10	5.25
07/25/87		4.54	3.58	3.04	3.00	3.02	3.08	3.01	3.10	5.17
07/26/87		4.54	3.58	3.04	3.00	3.02	3.08	3.01	3.10	5.22
07/27/87		4.54	3.58	3.04	3.00	3.02	3.08	3.01	3.10	4.99

Table 3C Continued

Date	Channels:	11 Therm3	12 Therm4	13 Pot184	17 Pot185	14 Pot186	21 Pot187	15 Pot188	25 Pot189	16 Pot190
	Cells:	219	221	184	185	186	187	188	189	190
	Values in:	(Volts)	(Volts)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)
07/28/87		4.55	3.58	3.04	3.00	3.02	3.08	3.01	3.10	4.75
07/29/87		4.54	3.58	3.04	3.00	3.02	3.08	3.01	3.10	4.73
07/30/87		4.54	3.58	3.04	3.00	3.01	3.08	3.01	3.10	4.73
07/31/87		4.54	3.58	3.04	3.00	3.01	3.08	3.01	3.10	4.72
08/01/87		4.54	3.58	3.04	3.00	3.01	3.08	3.01	3.10	4.71
08/02/87		4.54	3.58	3.04	3.00	3.01	3.08	3.01	3.10	4.75
08/03/87		4.54	3.58	3.05	3.00	3.01	3.08	3.01	3.10	4.81
08/04/87		4.54	3.58	3.04	3.00	3.01	3.06	3.01	3.10	4.80
08/05/87		4.54	3.58	3.04	3.00	3.01	3.08	3.01	3.10	4.70
08/06/87		4.54	3.58	3.04	3.00	3.01	3.08	3.01	3.10	4.71
08/07/87		4.54	3.58	3.04	3.00	3.01	3.03	3.01	3.10	4.71
08/08/87		4.54	3.58	3.04	3.00	3.01	3.08	3.01	3.10	4.71
08/09/87		4.54	3.58	3.05	3.00	3.01	3.08	3.01	3.10	4.71
08/10/87		4.54	3.58	3.05	3.00	3.01	3.06	3.01	3.10	4.71
08/11/87		4.54	3.58	3.04	3.00	3.01	3.07	3.01	3.10	4.72
08/12/87		4.54	3.59	3.04	3.00	3.01	3.07	3.01	3.10	4.72
08/13/87		4.54	3.58	3.04	3.00	3.01	3.07	3.01	3.10	4.73
08/14/87		4.54	3.58	3.04	3.00	3.01	3.07	3.01	3.10	4.74
08/15/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/16/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/17/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/18/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/19/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/20/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/21/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/22/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/23/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/24/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/25/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/26/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/27/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 3C Continued

Date	Channels:	11 Therm3	12 Therm4	13 Pot184	17 Pot185	14 Pot186	21 Pot187	15 Pot188	25 Pot189	16 Pot190
	Cells:	219	221	184	185	186	187	188	189	190
	Values in:	(Volts)	(Volts)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)
08/28/87		n/a	n/a	n/a	n/a	n/a	n/a.	n/a	n/a	n/a
08/29/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/30/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08/31/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/01/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/02/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/03/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/04/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/05/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/06/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/07/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/08/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/09/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/10/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/11/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/12/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/13/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/14/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/15/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/16/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/17/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/18/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/19/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/20/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/21/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/22/87		0.60	1.49	2.79	2.73	2.86	2.88	2.74	2.89	5.33
09/23/87		0.00	1.28	2.95	2.90	2.98	3.06	2.91	3.07	5.79
09/24/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/25/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/26/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/27/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 3C Continued

Date	Channels:	11 Thera3	12 Thera4	13 Pot184	17 Pot185	14 Pot186	21 Pot187	15 Pot188	25 Pot189	16 Pot190
	Cells:	219	221	184	185	186	187	188	189	190
	Values in:	(Volts)	(Volts)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)
09/28/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/29/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09/30/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/01/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/02/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/03/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/04/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/05/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/06/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/07/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/08/87		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10/09/87		4.56	3.62	5.63	2.89	5.58	3.06	5.68	3.07	5.77
10/10/87		4.57	3.62	5.81	2.89	5.75	3.06	5.86	3.07	5.77
10/11/87		4.57	3.62	5.81	2.89	5.75	3.06	5.86	3.07	5.77
10/12/87		4.56	3.62	5.80	2.89	5.75	3.06	5.85	3.07	5.77
10/13/87		4.56	3.61	5.78	2.89	5.72	3.06	5.83	3.07	5.77
10/14/87		4.56	3.61	5.77	2.89	5.71	3.06	5.82	3.07	5.77
10/15/87		4.55	3.61	5.80	2.89	5.74	3.06	5.85	3.07	5.77
10/16/87		4.56	3.61	5.82	2.89	5.76	3.06	5.87	3.07	5.77
10/17/87		4.54	3.60	5.82	2.89	5.76	3.06	5.87	3.08	5.77
10/18/87		4.54	3.60	5.82	2.89	5.76	3.06	5.87	3.08	5.77
10/19/87		4.54	3.60	5.82	2.89	5.76	3.06	5.87	3.08	5.77
10/20/87		4.55	3.61	5.82	2.89	5.76	3.06	5.87	3.08	5.77
10/21/87		4.55	3.61	5.82	2.89	5.76	3.06	5.87	3.07	5.77
10/22/87		4.55	3.61	5.82	2.89	5.76	3.06	5.87	3.08	5.77
10/23/87		4.55	3.61	5.82	2.88	5.76	3.06	5.87	3.07	5.77
10/24/87		4.55	3.61	5.82	2.88	5.76	3.06	5.87	3.08	5.77
10/25/87		4.55	3.61	5.82	2.88	5.76	3.06	5.87	3.07	5.77
10/26/87		4.54	3.61	5.82	2.88	5.76	3.06	5.87	3.08	5.77
10/27/87		4.55	3.61	5.82	2.88	5.76	3.06	5.87	3.08	5.77
10/28/87		4.55	3.61	5.82	2.88	5.76	3.06	5.87	3.06	5.77

Table 3C Continued

Date	Channels:	11 Therm3	12 Therm4	13 Pot184	17 Pot185	14 Pot186	21 Pot187	15 Pot188	25 Pot189	16 Pot190
	Cells:	219	221	184	185	186	187	188	189	190
	Values in:	(Volts)	(Volts)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)
10/29/87		4.54	3.59	5.82	2.86	5.76	3.06	5.87	3.08	5.77
10/30/87		4.54	3.59	5.82	2.86	5.76	3.06	5.87	3.08	5.77
10/31/87		4.54	3.60	5.82	2.86	5.76	3.07	5.87	3.08	5.77
11/01/87		4.54	3.59	5.82	2.85	5.76	3.07	5.87	3.08	5.77
11/02/87		4.53	3.59	5.82	2.85	5.76	3.07	5.87	3.08	5.77
11/03/87		4.53	3.59	5.82	2.85	5.76	3.07	5.87	3.08	5.77
11/04/87		4.53	3.59	5.82	2.85	5.76	3.07	5.87	3.08	5.77
11/05/87		4.53	3.59	5.82	2.85	5.76	3.07	5.87	3.08	5.77
11/06/87		4.54	3.58	5.82	2.85	5.76	3.07	5.87	3.08	5.77
11/07/87		4.54	3.58	5.82	2.84	5.76	3.07	5.87	3.08	5.77
11/08/87		4.54	3.58	5.82	2.84	5.76	3.07	5.87	3.08	5.77
11/09/87		4.54	3.58	5.82	2.84	5.76	3.07	5.87	3.08	5.77
11/10/87		4.54	3.58	5.82	2.84	5.76	3.07	5.87	3.08	5.77
11/11/87		4.54	3.58	5.82	2.84	5.76	3.07	5.87	3.08	5.77
11/12/87		4.54	3.58	5.82	2.83	5.76	3.07	5.87	3.08	5.77
11/13/87		4.55	3.58	5.82	2.83	5.76	3.07	5.87	3.08	5.77
11/14/87		4.55	3.59	5.82	2.83	5.76	3.07	5.87	3.08	5.77
11/15/87		4.55	3.59	5.82	2.83	5.76	3.06	5.87	3.08	5.77
11/16/87		4.55	3.59	5.82	2.83	5.76	3.07	5.87	3.08	5.77
11/17/87		4.55	3.59	5.82	2.83	5.76	3.07	5.87	3.07	5.77
11/18/87		4.55	3.59	5.79	2.83	5.73	3.07	5.84	3.08	5.77
11/19/87		4.55	3.58	5.79	2.83	5.74	3.07	5.84	3.07	5.77
11/20/87		4.55	3.58	5.79	2.83	5.73	3.07	5.84	3.08	5.77
11/21/87		4.55	3.58	5.80	2.83	5.74	3.07	5.85	3.08	5.77
11/22/87		4.55	3.59	5.81	2.83	5.75	3.07	5.86	3.08	5.77
11/23/87		4.55	3.59	5.81	2.83	5.75	3.07	5.86	3.08	5.77
11/24/87		4.55	3.59	5.81	2.83	5.75	3.07	5.86	3.08	5.77
11/25/87		4.55	3.59	5.81	2.83	5.75	3.07	5.85	3.08	5.77
11/26/87		4.55	3.59	5.80	2.83	5.74	3.07	5.85	3.08	5.77
11/27/87		4.55	3.59	5.79	2.83	5.73	3.07	[illegible]	3.07	5.77
11/28/87		4.55	3.59	5.75	2.83	5.69	3.07	5.79	3.08	5.77

Table 3C Continued

Date	Channels:	11 Therm3	12 Therm4	13 Pot184	17 Pot185	14 Pot186	21 Pot187	15 Pot188	25 Pot189	16 Pot190
	Cells:	219	221	184	185	186	187	188	189	190
	Values in:	(Volts)	(Volts)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)
11/29/87		4.55	3.59	5.75	2.83	5.69	3.07	5.80	3.07	5.77
11/30/87		4.55	3.59	5.75	2.83	5.69	3.07	5.80	3.07	5.77
12/01/87		4.55	3.59	5.76	2.83	5.71	3.07	5.81	3.07	5.77
12/02/87		4.55	3.59	5.77	2.83	5.71	3.07	5.82	3.08	5.77
12/03/87		4.55	3.59	5.77	2.83	5.71	3.07	5.82	3.08	5.77
12/04/87		4.55	3.59	5.80	2.83	5.74	3.07	5.85	3.08	5.77
12/05/87		4.55	3.59	5.80	2.82	5.74	3.07	5.85	3.07	5.77
12/06/87		4.55	3.59	5.80	2.82	5.74	3.07	5.85	3.07	5.77
12/07/87		4.55	3.59	5.79	2.82	5.73	3.07	5.84	3.07	5.77
12/08/87		4.55	3.59	5.79	2.82	5.73	3.07	5.84	3.07	5.77
12/09/87		4.55	3.59	5.79	2.82	5.73	3.07	5.84	3.07	5.77
12/10/87		4.55	1.11	5.82	2.82	5.76	3.07	5.87	3.08	5.77
12/11/87		4.55	1.10	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/12/87		4.55	1.10	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/13/87		4.55	1.10	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/14/87		4.54	1.11	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/15/87		4.54	1.11	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/16/87		4.54	1.12	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/17/87		4.54	1.12	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/18/87		4.54	1.12	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/19/87		4.54	1.12	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/20/87		4.54	1.13	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/21/87		4.54	1.13	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/22/87		4.54	1.13	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/23/87		4.54	1.13	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/24/87		4.54	1.13	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/25/87		4.54	1.14	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/26/87		4.54	1.14	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/27/87		4.53	1.14	5.82	2.82	5.76	3.07	5.87	3.07	5.77
12/28/87		4.53	1.14	5.82	2.82	5.76	3.07	5.87	3.07	5.77

Table 3C Continued

Date	Channels:	11 Therm3	12 Therm4	13 Pot184	17 Pot185	14 Pot186	21 Pot187	15 Pot188	25 Pot189	16 Pot190
	Cells:	219	221	184	185	186	187	188	189	190
	Values in:	(Volts)	(Volts)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)
12/30/87		4.53	1.14	5.82	2.81	5.76	3.07	5.87	3.07	5.77
12/31/87		4.53	1.14	5.82	2.81	5.76	3.07	5.87	3.07	5.77
01/01/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/02/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/03/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/04/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/05/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/06/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/07/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/08/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/09/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/10/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/11/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/12/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/13/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/14/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/15/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/16/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/17/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77
01/18/88		4.53	1.14	5.82	2.81	5.76	3.06	5.87	3.07	5.77

Figure 1C TIME VS MINING

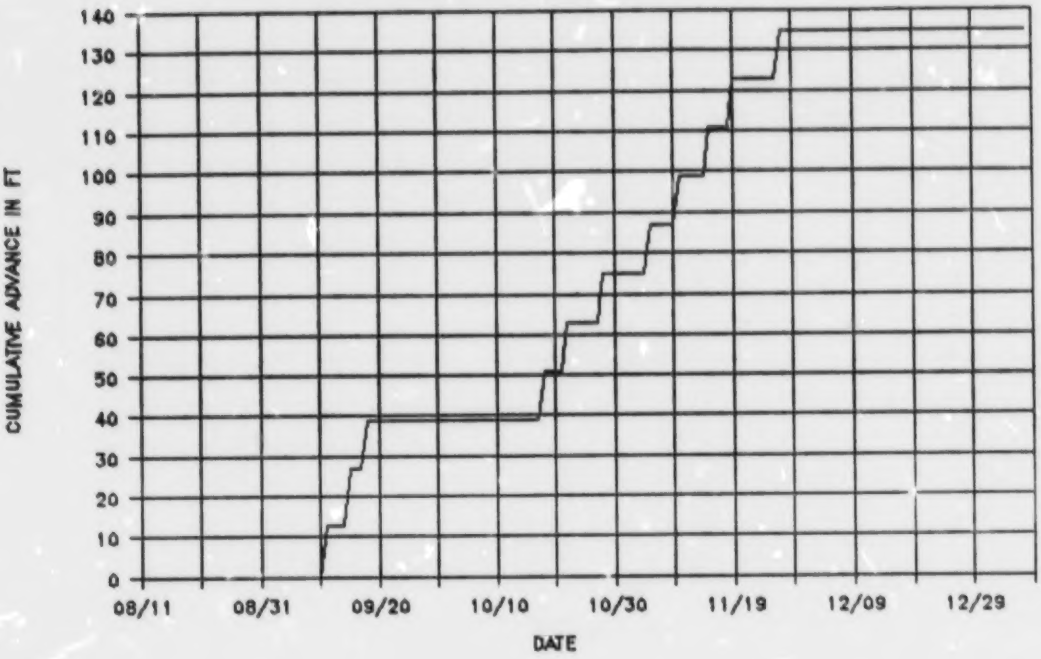


FIGURE 2C EARTH PRESSURE CELL 176

45 DEGREE PERPENDICULAR TO STOPE

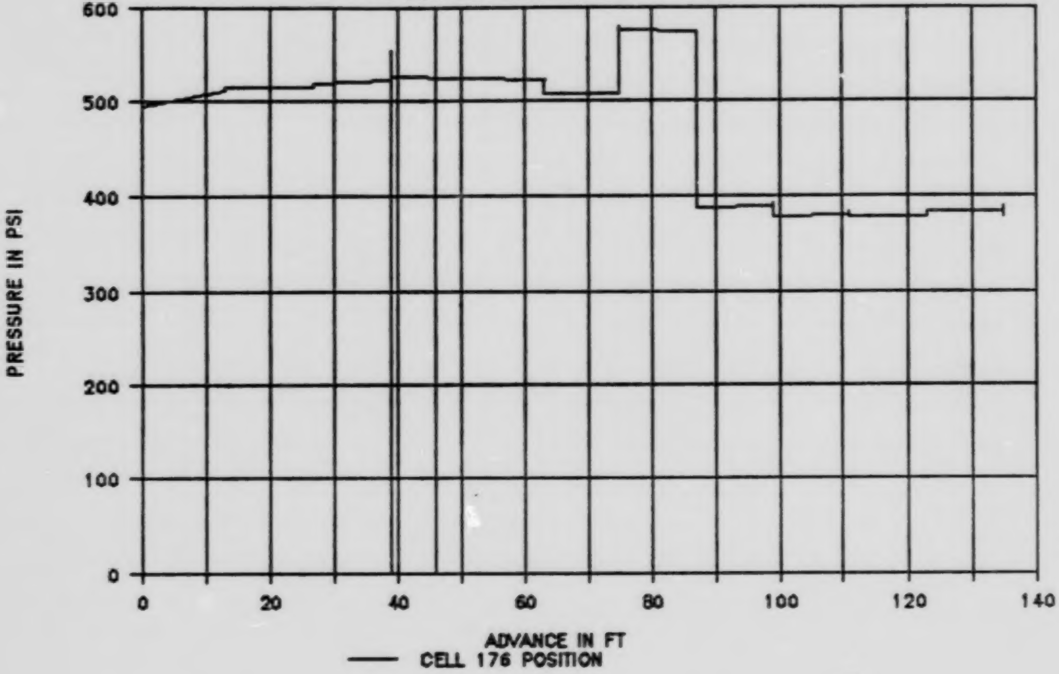


Figure 3C EARTH PRESSURE CELL 177

45 DEGREE PERPENDICULAR TO STOPE

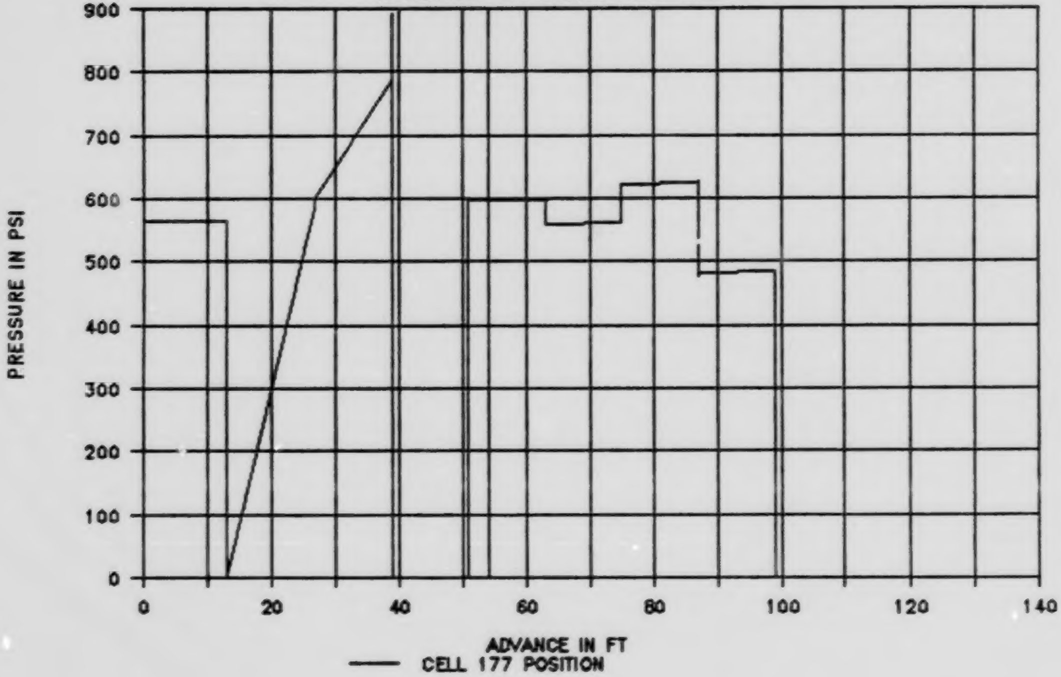


FIGURE 4C EARTH PRESSURE CELL 178

45 DEGREE PERPENDICULAR TO STOPE

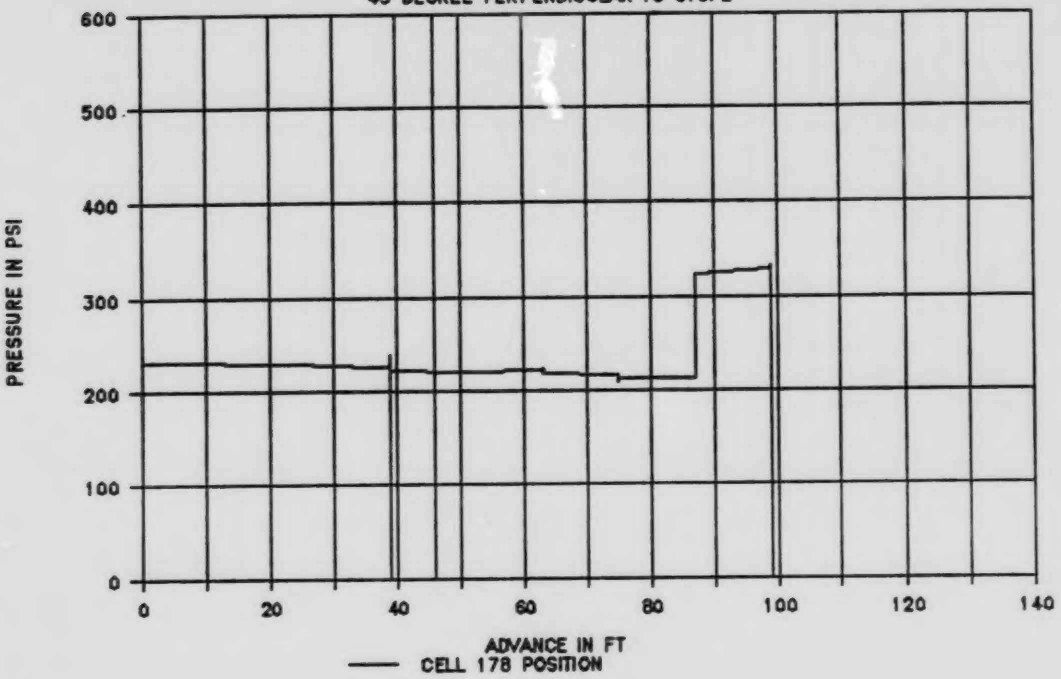


Figure 5C EARTH PRESSURE CELL 179

VERTICAL PARALLEL TO STOPE

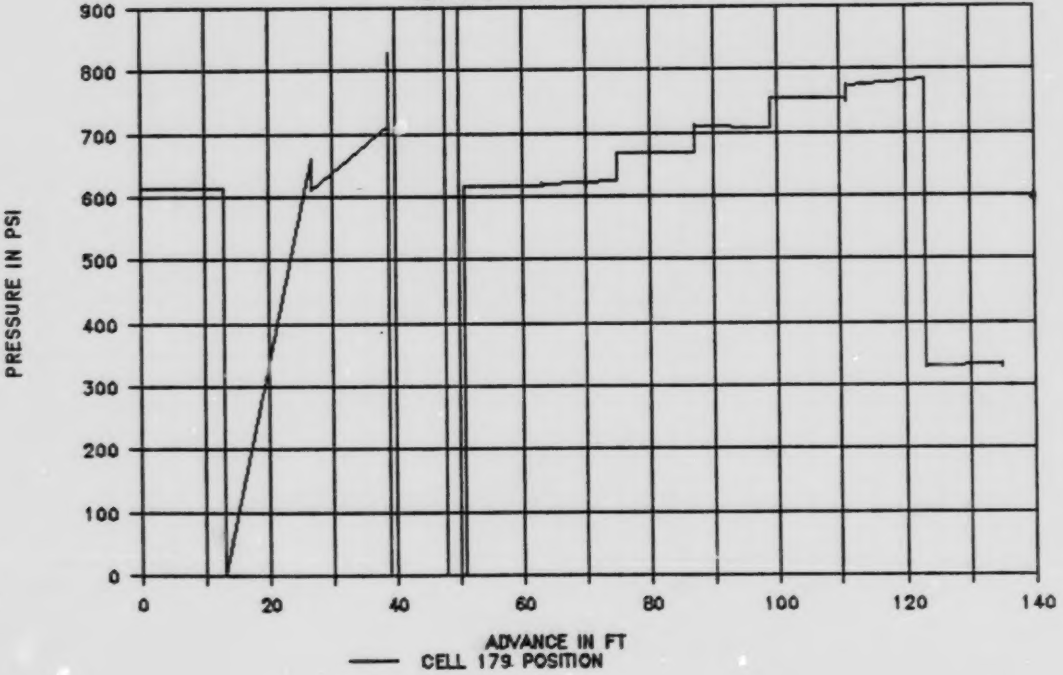


FIGURE 6C EARTH PRESSURE CELL 180

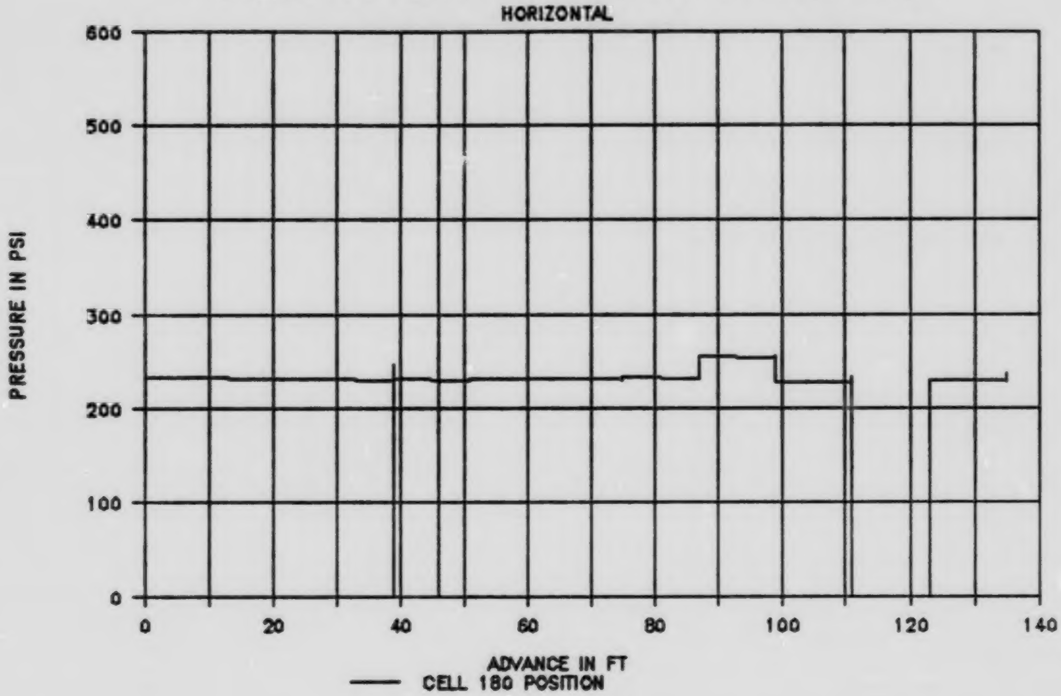


FIGURE 7C EARTH PRESSURE CELL 181

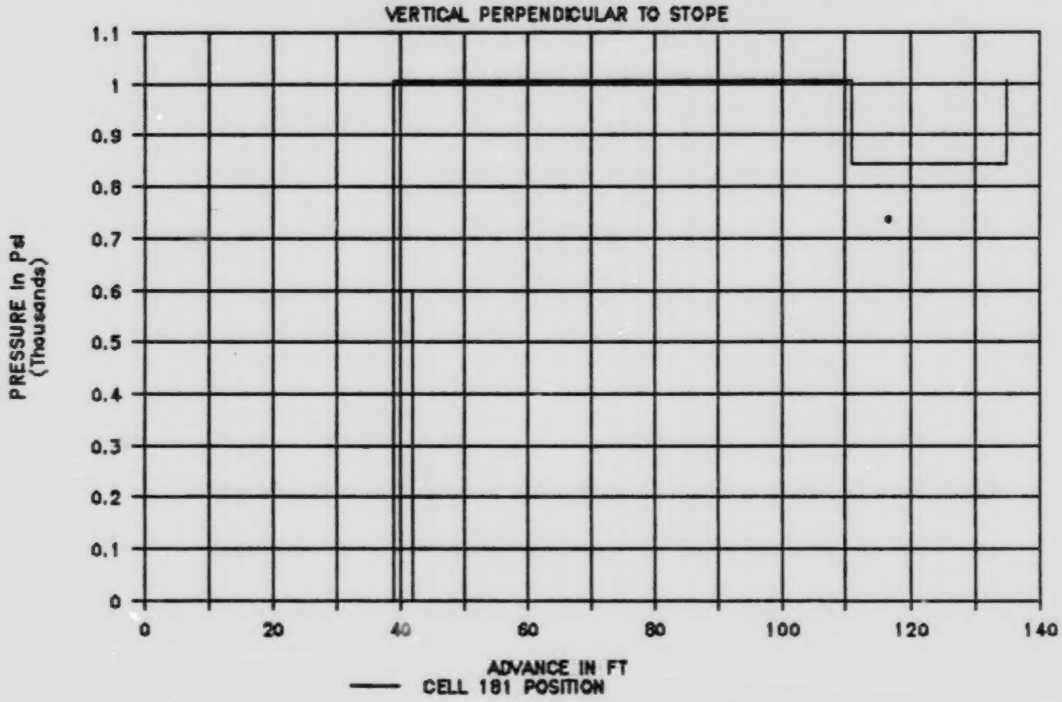


Figure 8C EARTH PRESSURE CELL 182

45 DEGREE PARALLEL TO STOPE

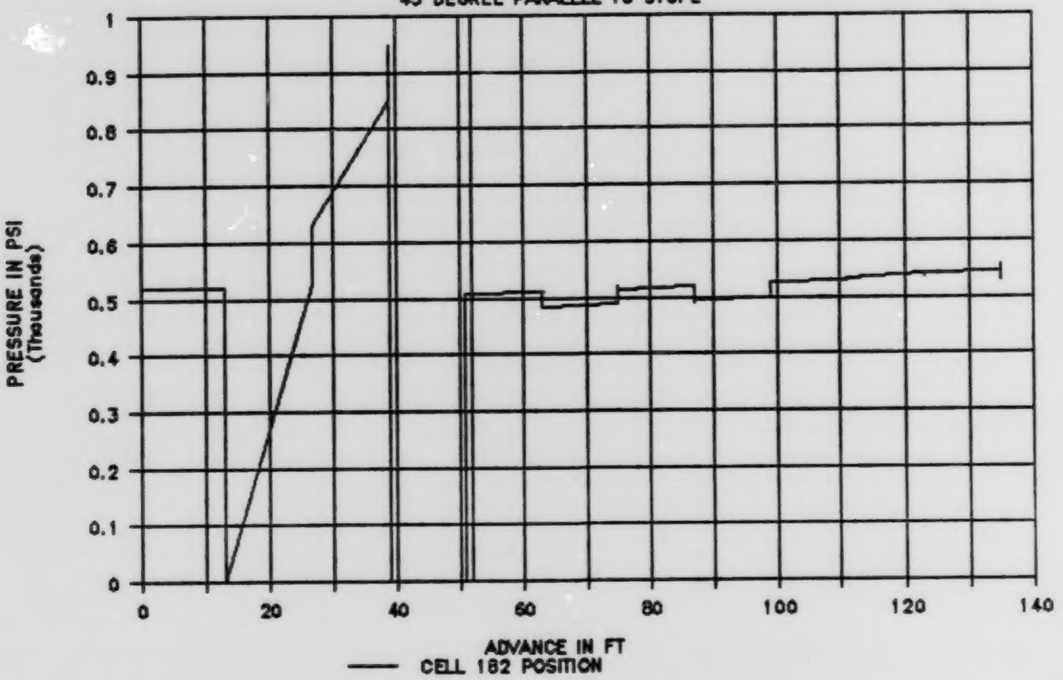


Figure 9C EARTH PRESSURE CELL 183

45 DEGREE PARALLEL TO STOPE

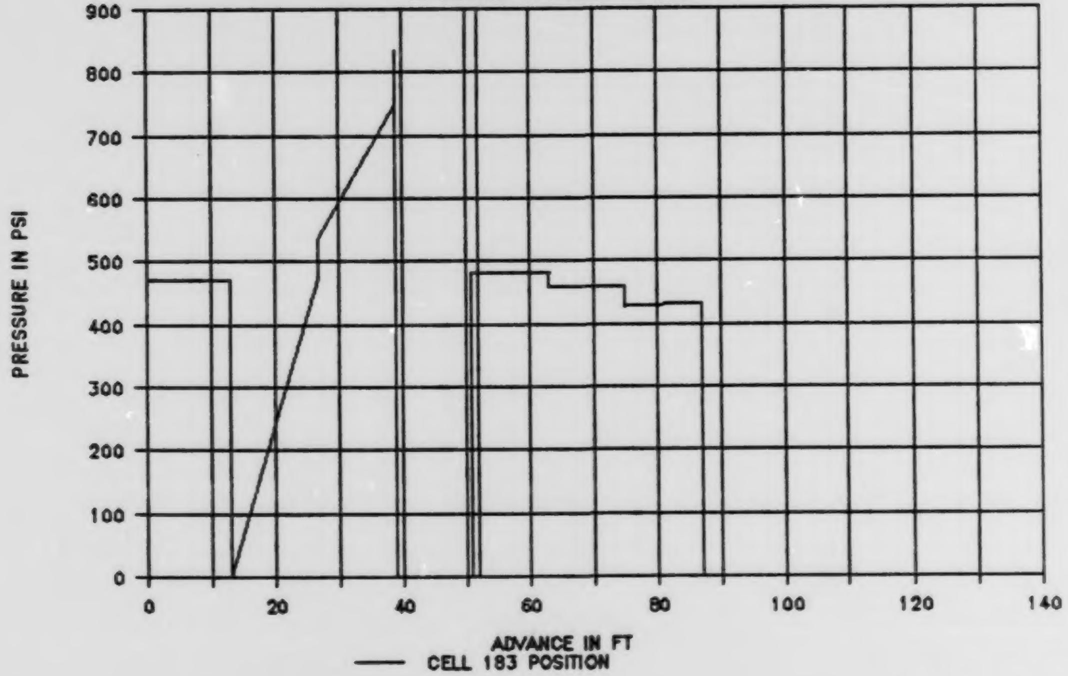


FIGURE 10C EARTH PRESSURE CELL 184

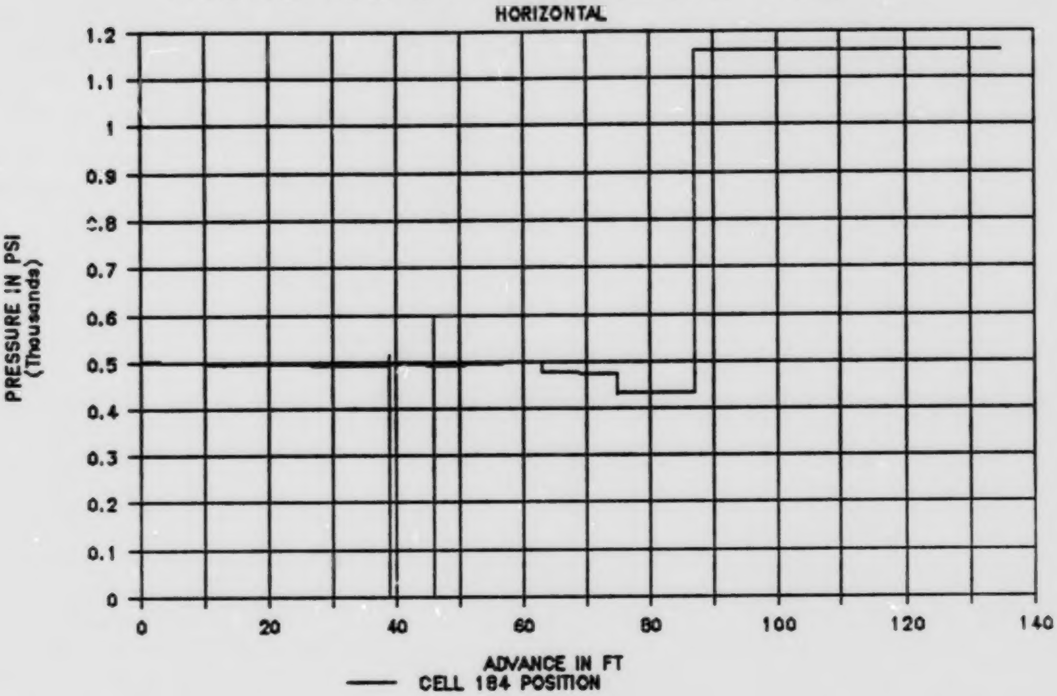


Figure 11C EARTH PRESSURE CELL 185

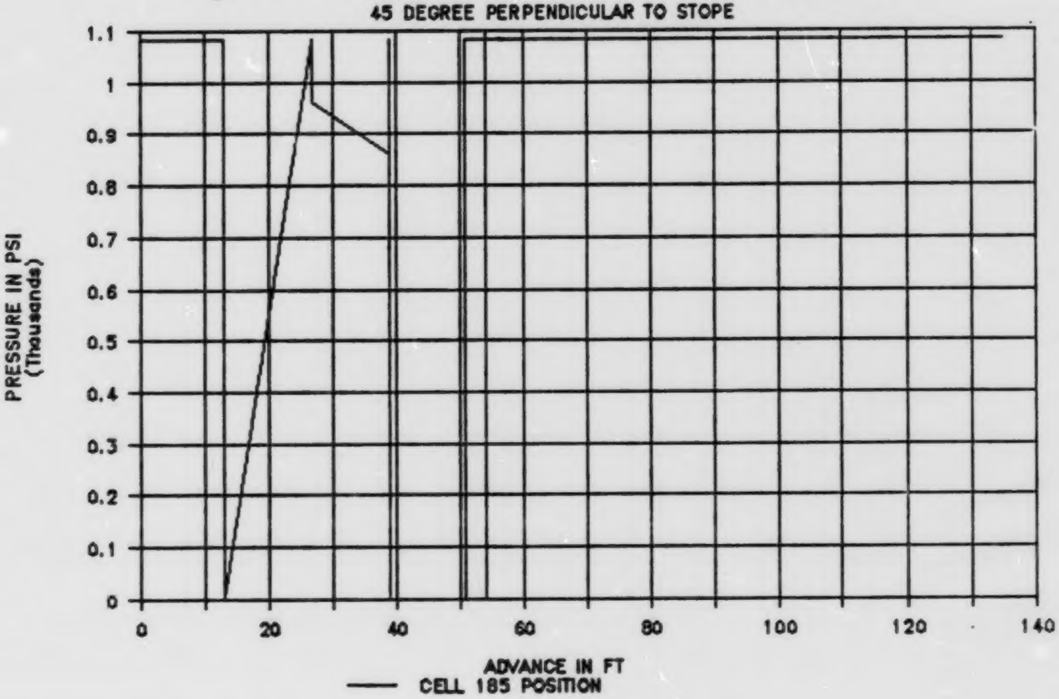


FIGURE 12C EARTH PRESSURE CELL 187

45 DEGREE PERPENDICULAR TO STOPE

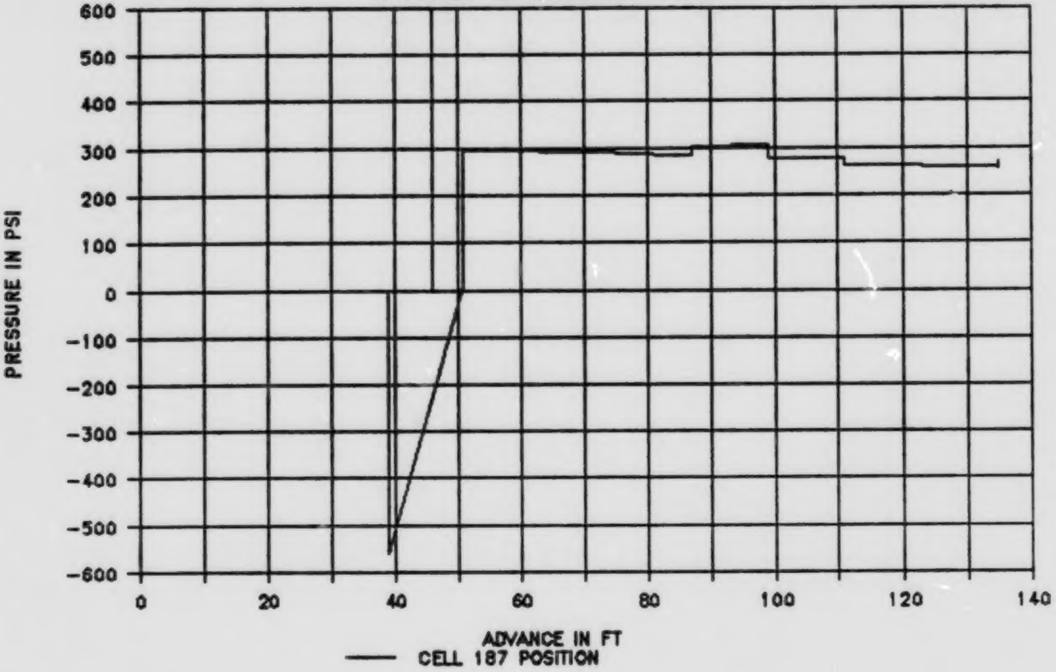


FIGURE 13C EARTH PRESSURE CELL 188

VERTICAL PARALLEL TO STOPE

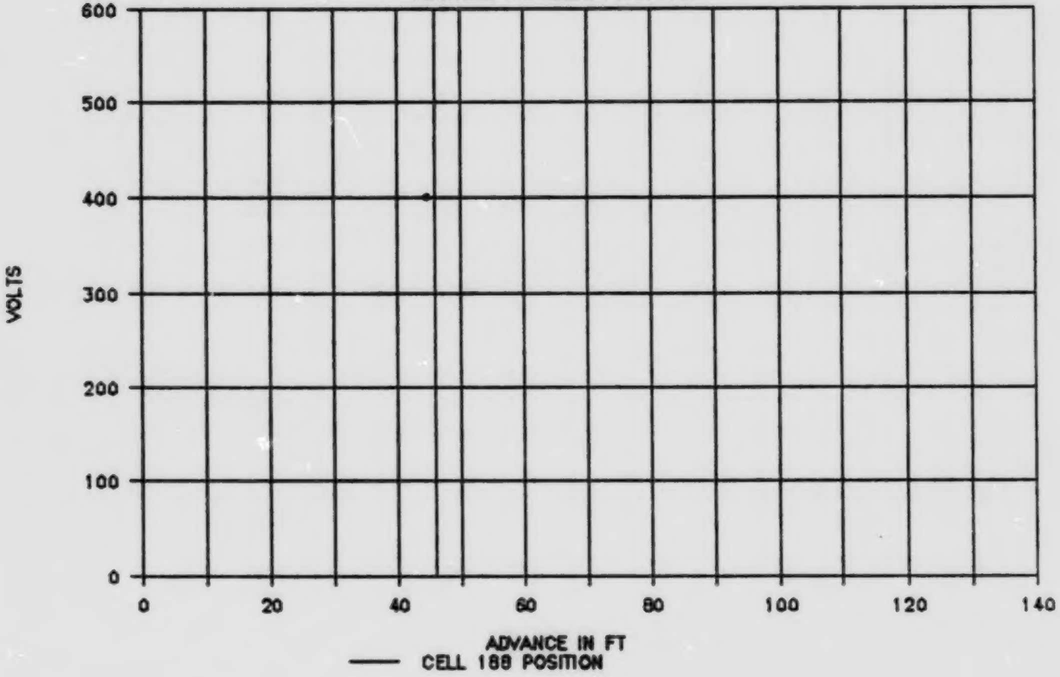


FIGURE 13.1 EARTH PRESSURE CELL 188

VERTICAL PERPENDICULAR TO STOPE

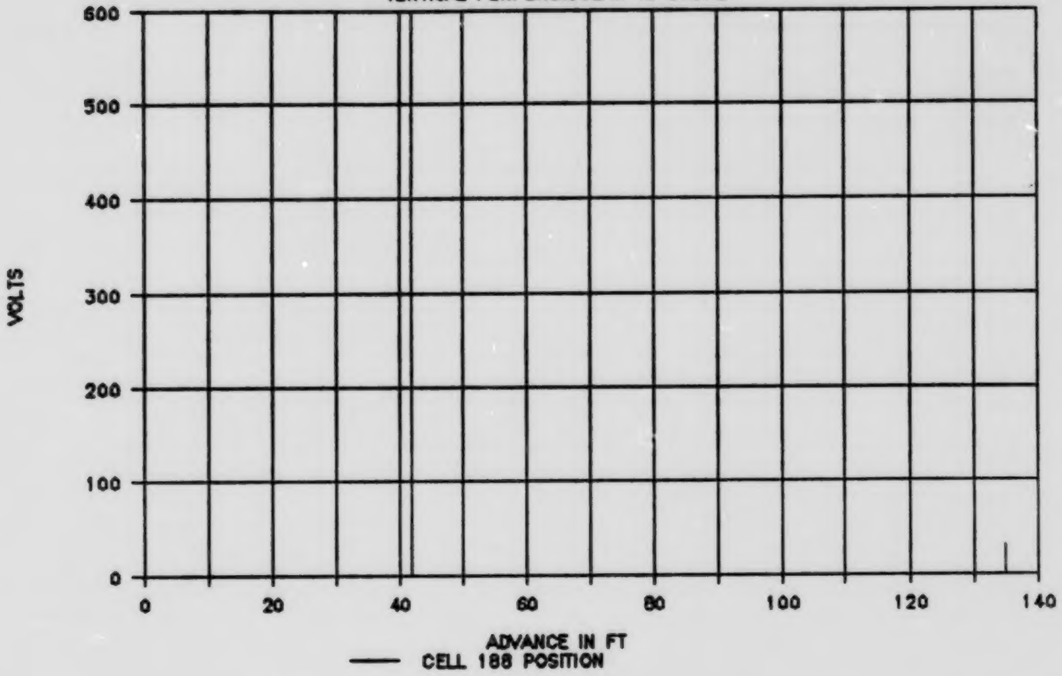


Figure 14C EARTH PRESSURE CELL 189

HORIZONTAL

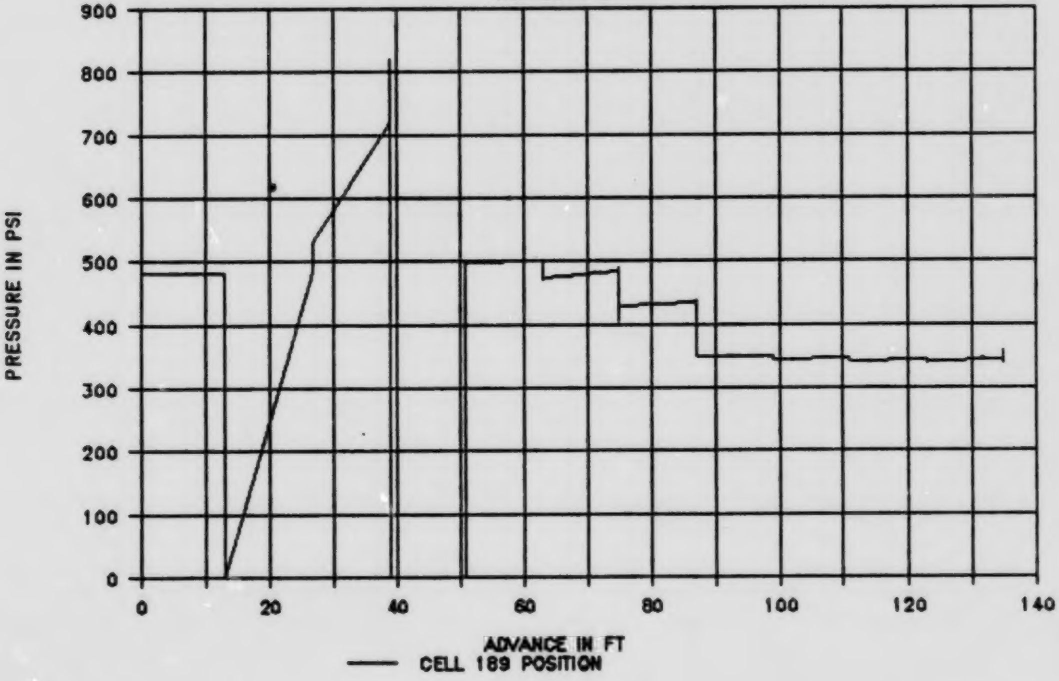


Figure 15C EARTH PRESSURE CELL 190

HORIZONTAL

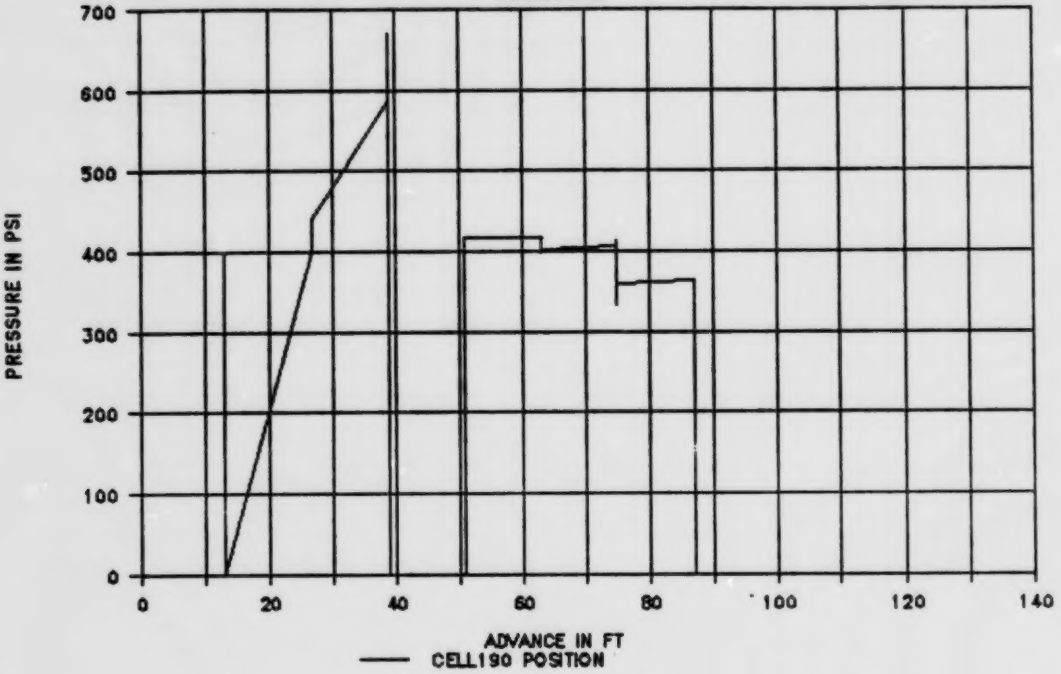


FIGURE 16C EARTH PRESSURE CELL 191

45 DEGREE PARALLEL TO STOPE

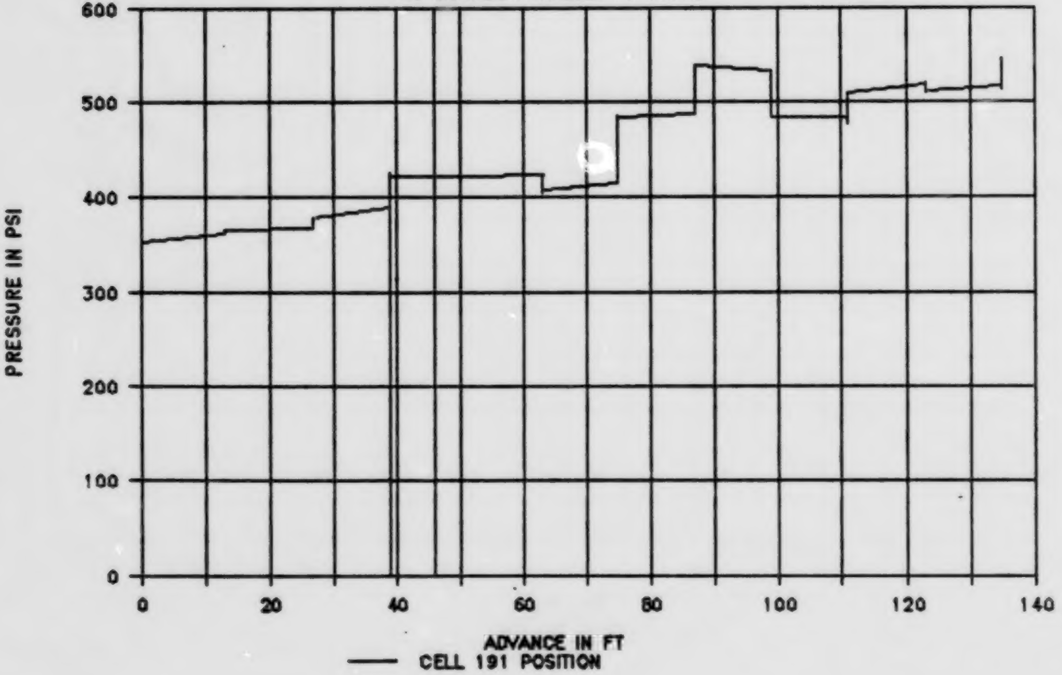


FIGURE 17C EARTH PRESSURE CELL 192

45 DEGREE PARALLEL TO STOPE

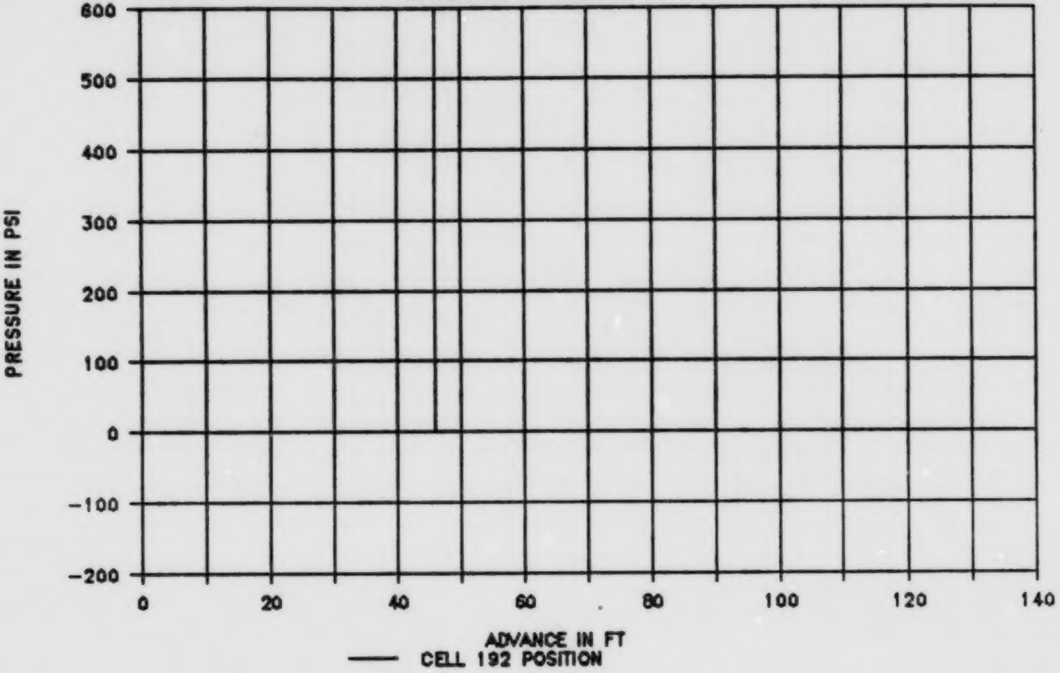


Figure 18C EARTH PRESSURE CELL 194

VERTICAL PARALLEL TO STOPE

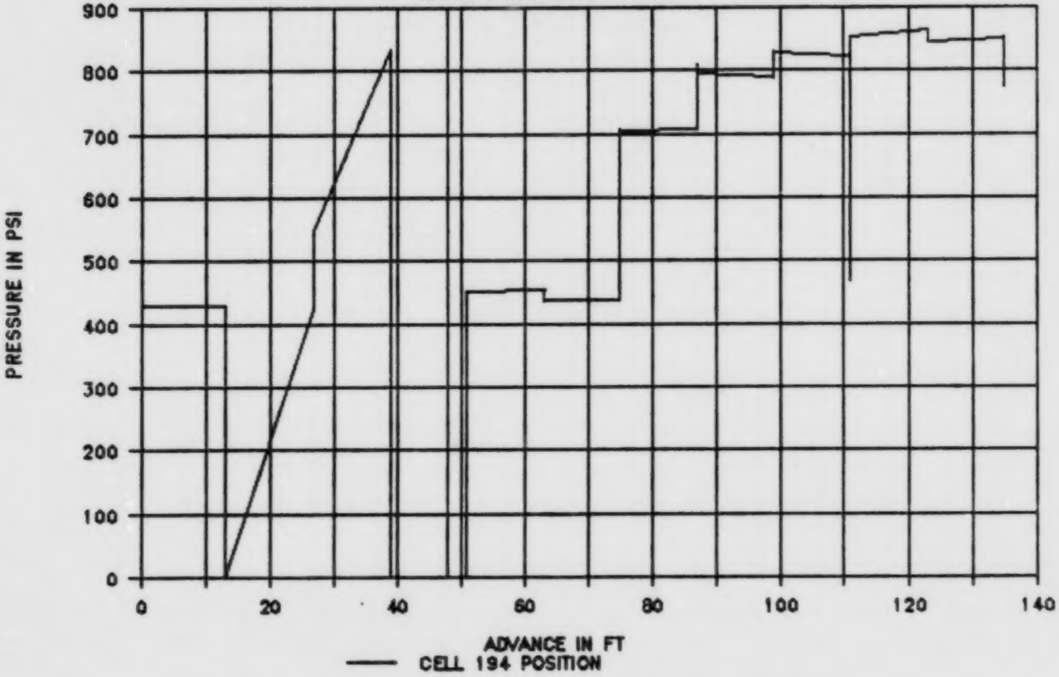


FIGURE 19C EARTH PRESSURE CELL 195

45 DEGREE PARALLEL TO STOPE

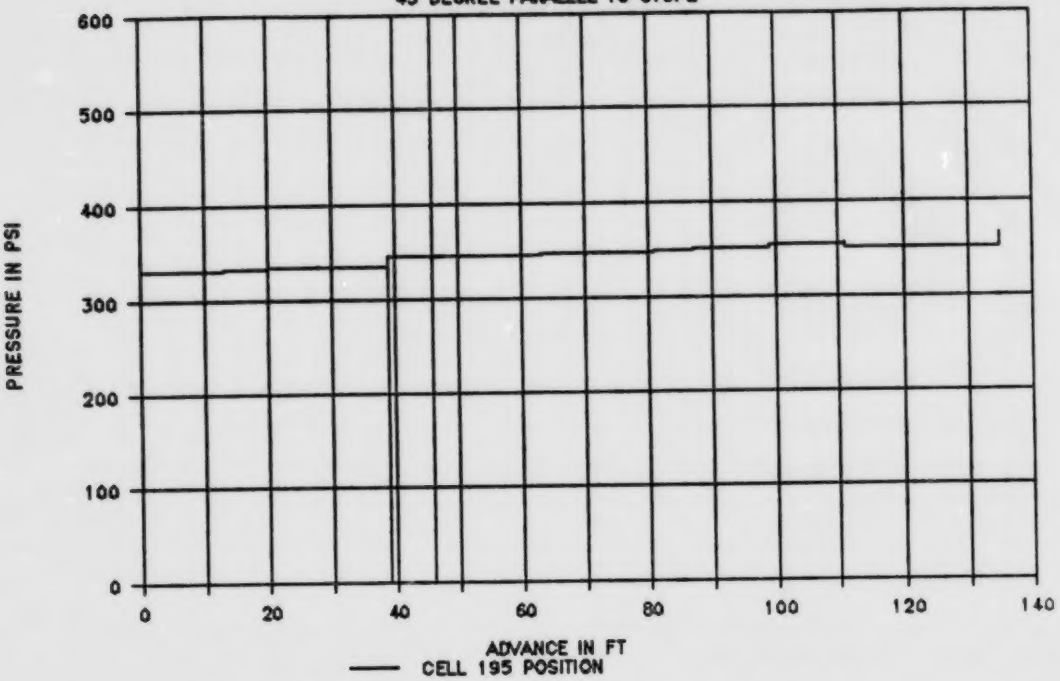


FIGURE 20C EARTH PRESSURE CELL 198

HORIZONTAL

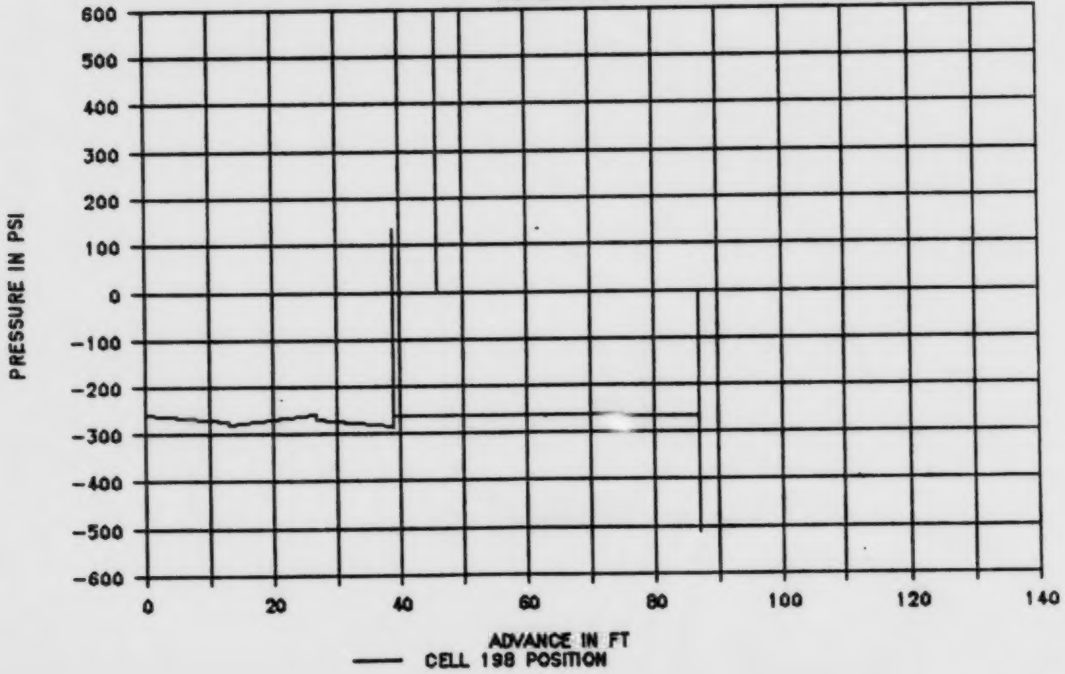


FIGURE 21C EARTH PRESSURE CELL 199

HORIZONTAL

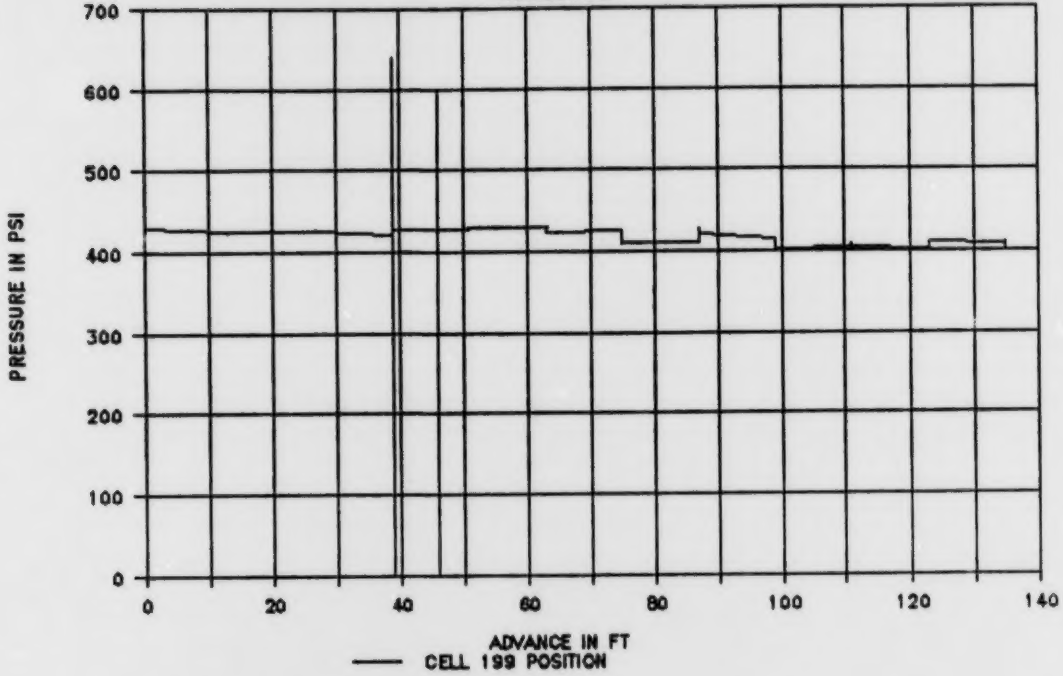


Figure 22C EARTH PRESSURE CELL 200

VERTICAL PERPENDICULAR TO STOPE

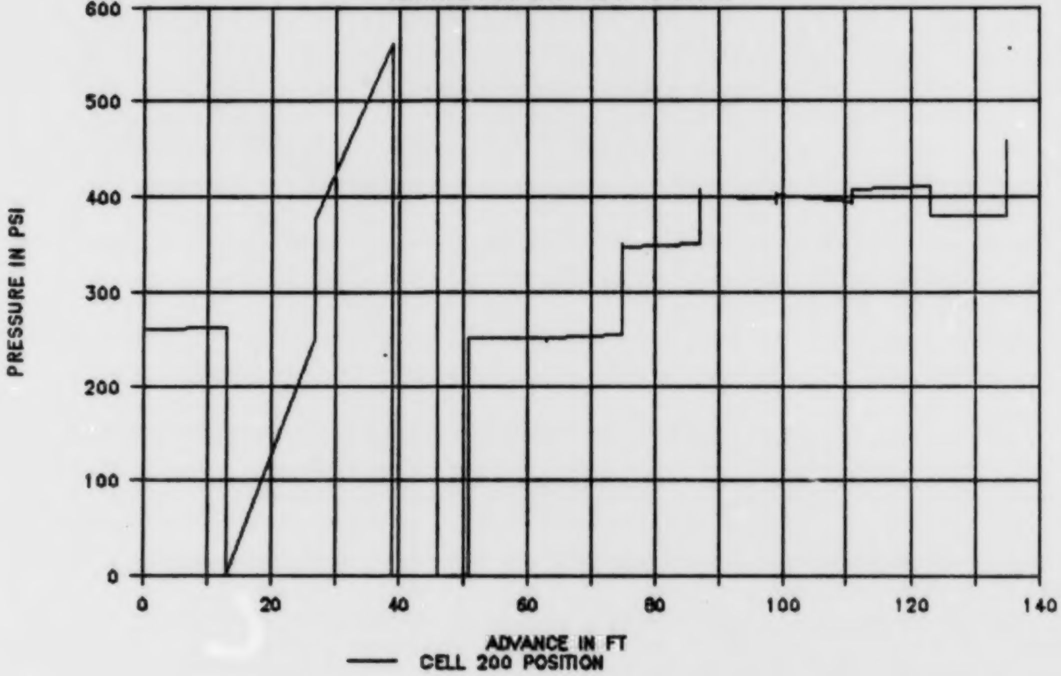


FIGURE 23C EARTH PRESSURE CELL 201

VERTICAL PARALLEL TO STOPE

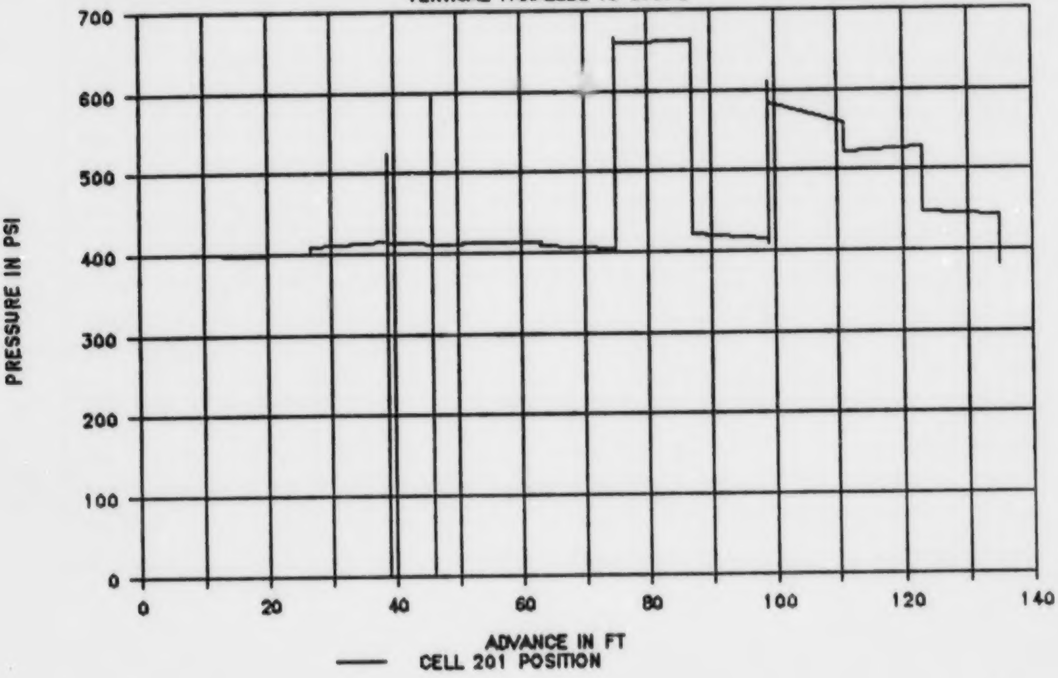


FIGURE 24C EARTH PRESSURE CELL 202

45 DEGREE PARALLEL TO STOPE

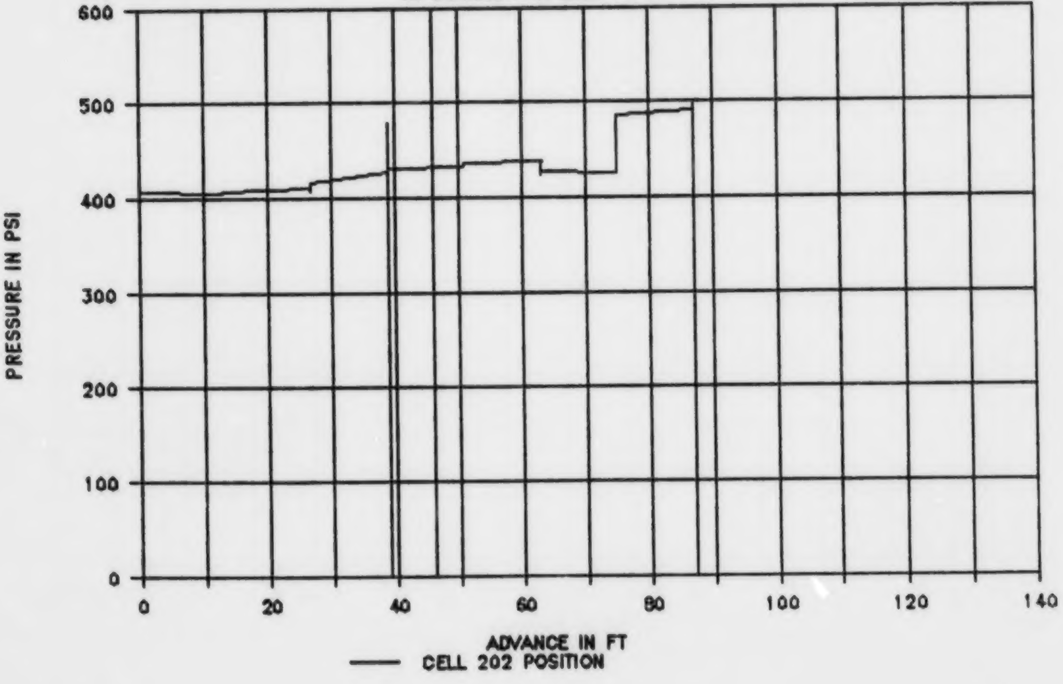


Figure 25C EARTH PRESSURE CELL 203

VERTICAL PARALLEL TO STOPE

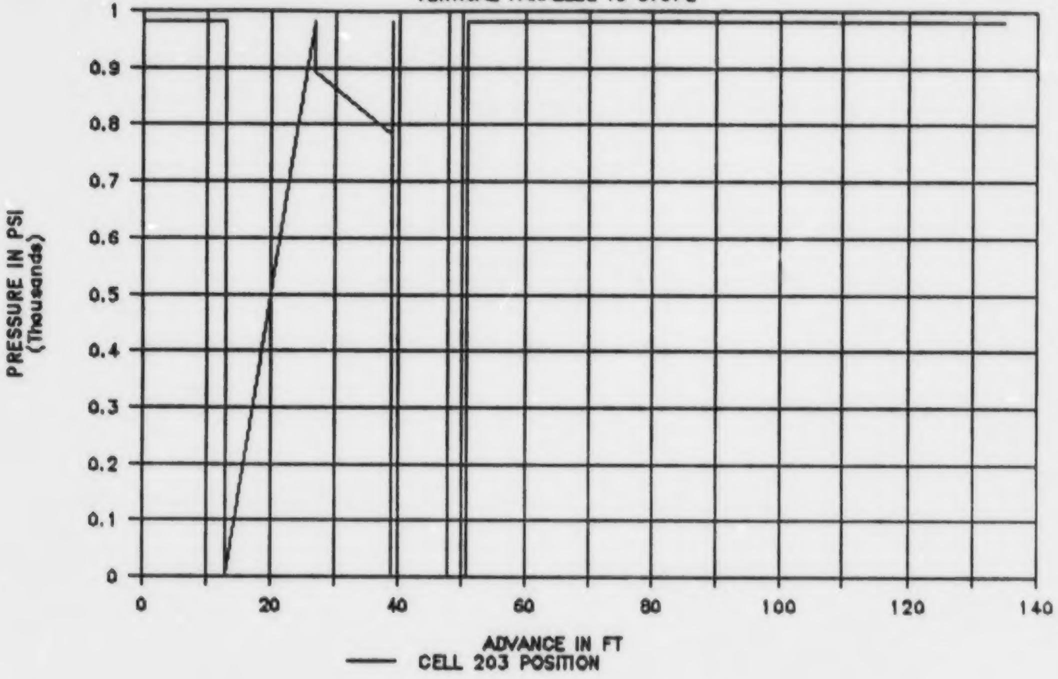


FIGURE 26C EARTH PRESSURE CELL 204

45 DEGREE PERPENDICULAR TO STOPE

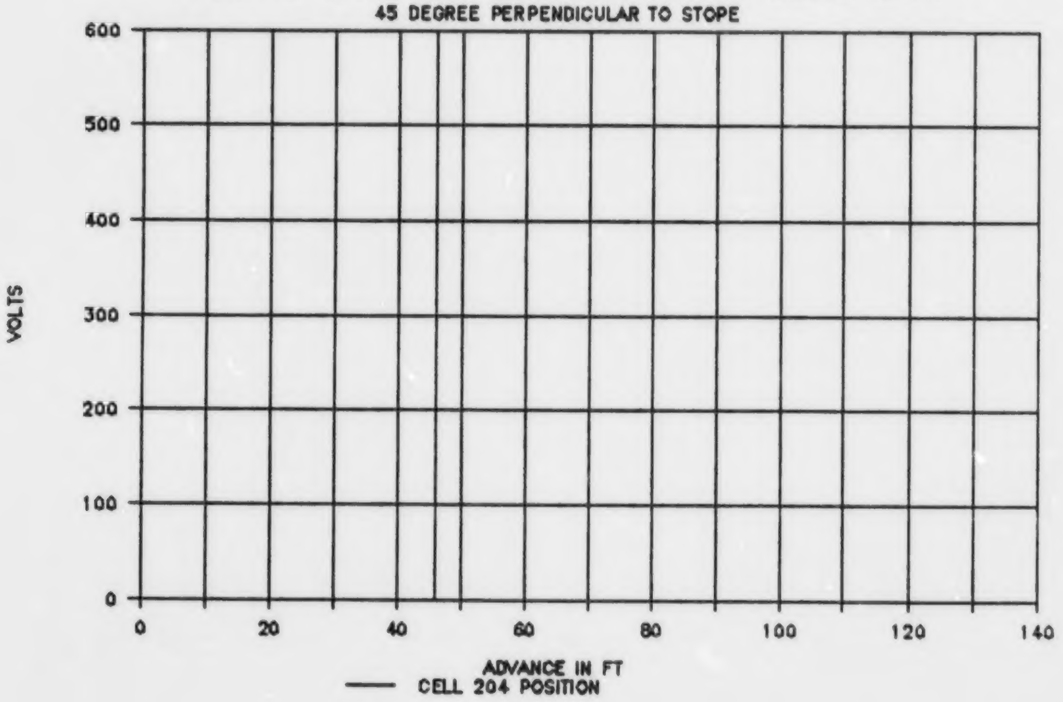


Figure 27C EARTH PRESSURE CELL 205

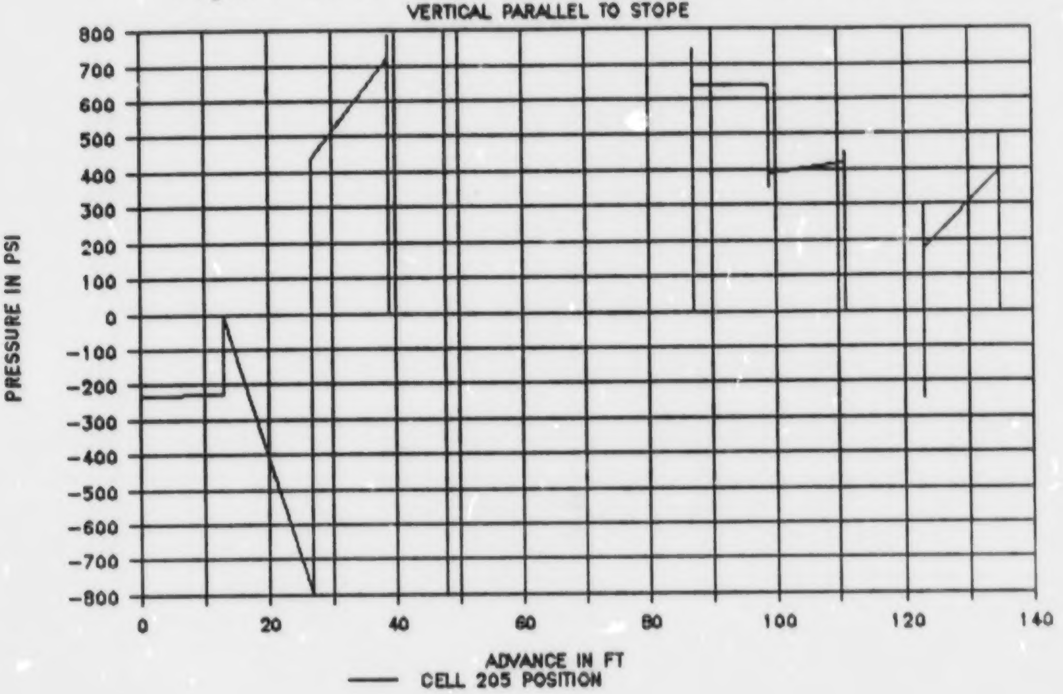

VERTICAL PARALLEL TO STOPE

FIGURE 28C EARTH PRESSURE CELL 206

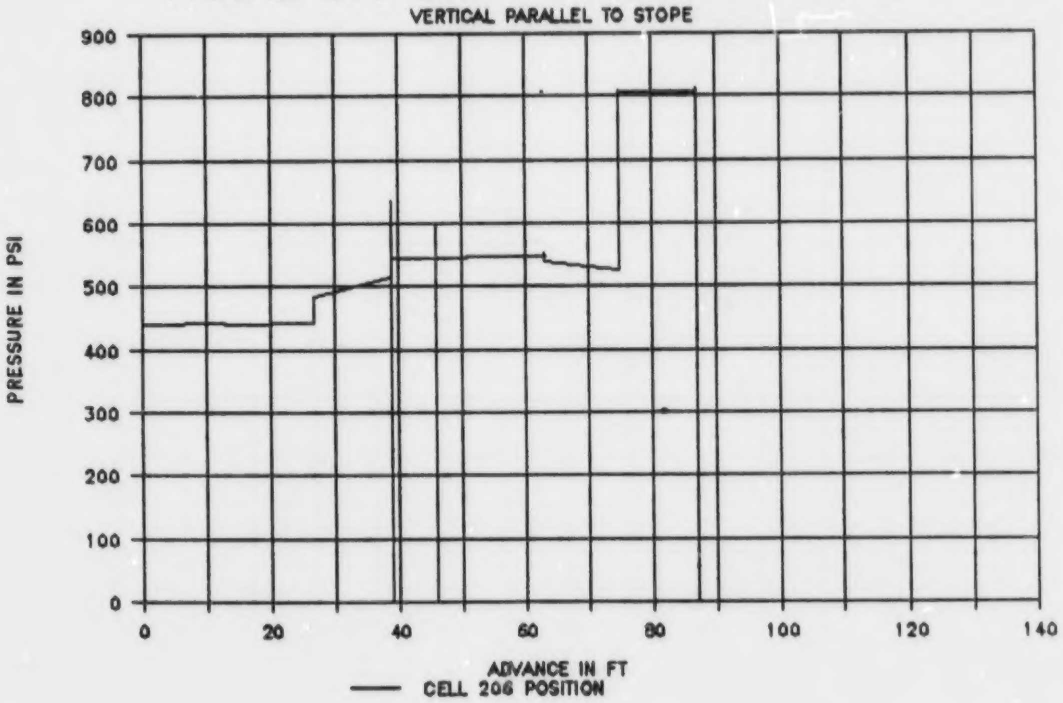

VERTICAL PARALLEL TO STOPE

Figure 29C EARTH PRESSURE CELL 213

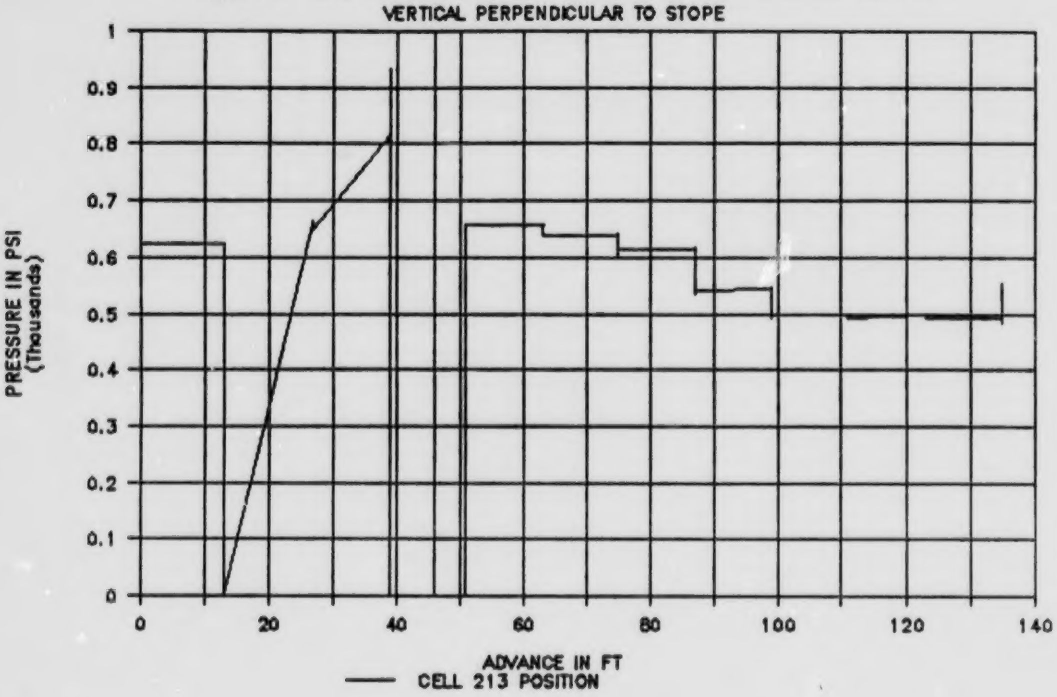

VERTICAL PERPENDICULAR TO STOPE

Figure 30C EARTH PRESSURE CELL 214

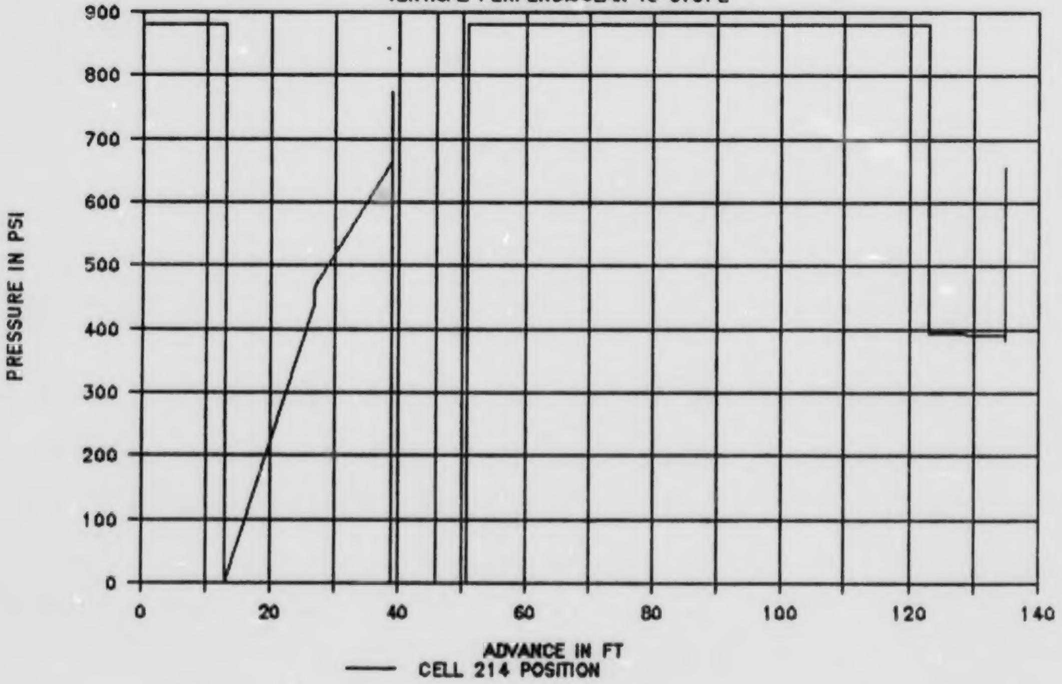

VERTICAL PERPENDICULAR TO STOPE

Figure 31C EARTH PRESSURE CELL 215

VERTICAL PARALLEL TO STOPE

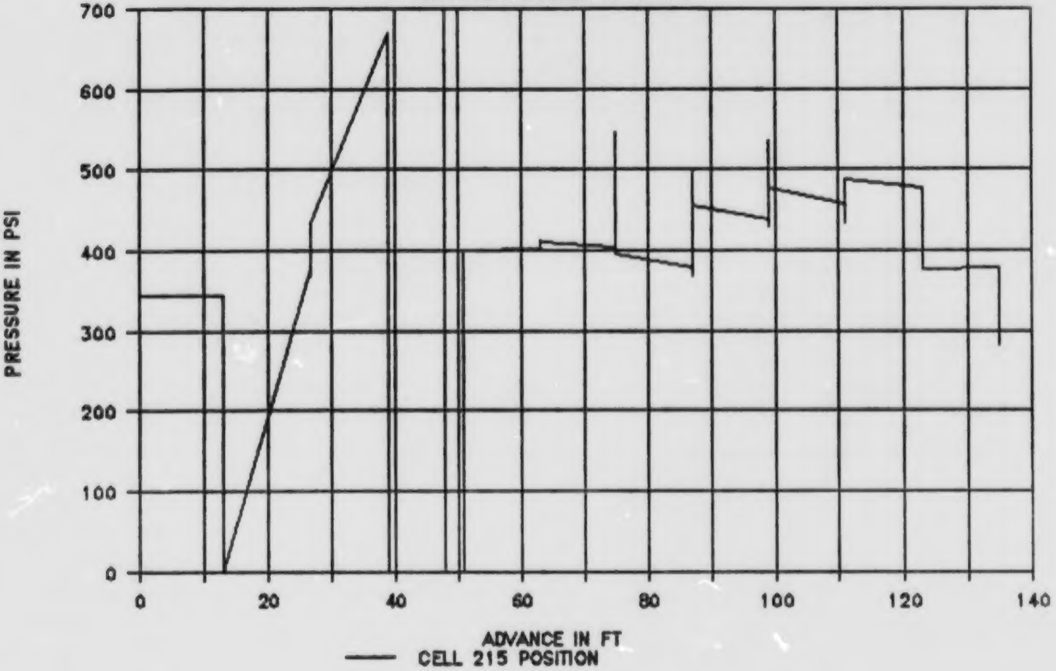


Figure 32C EARTH PRESSURE CELL 216

VERTICAL PARALLEL TO STOPE

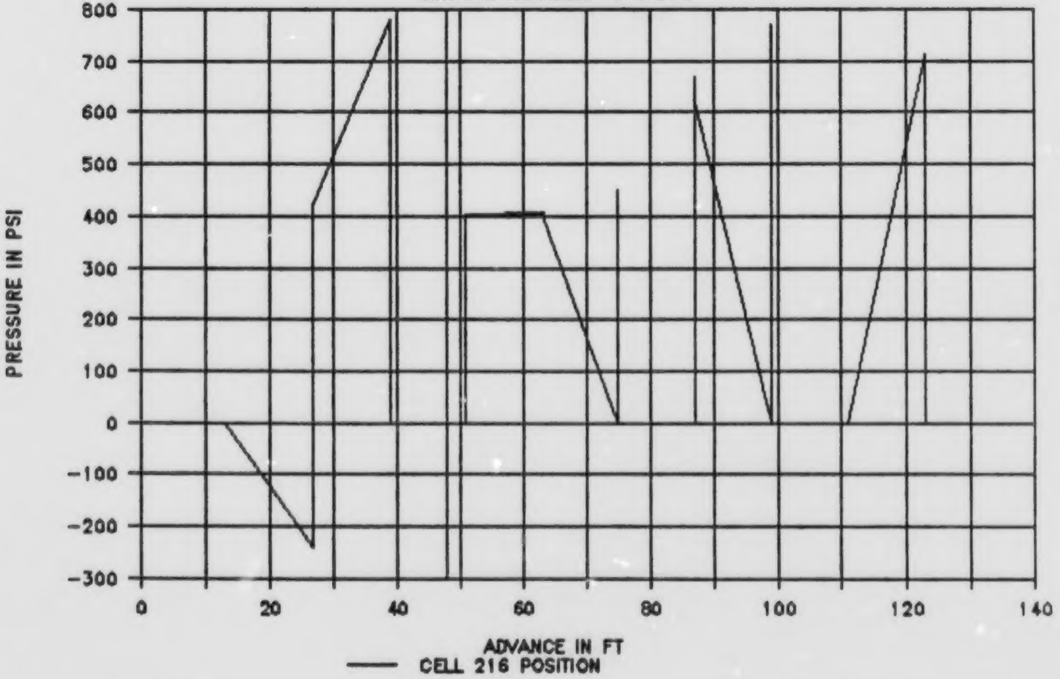


Figure 33C EARTH PRESSURE CELL 217

VERTICAL PARALLEL TO STOPE

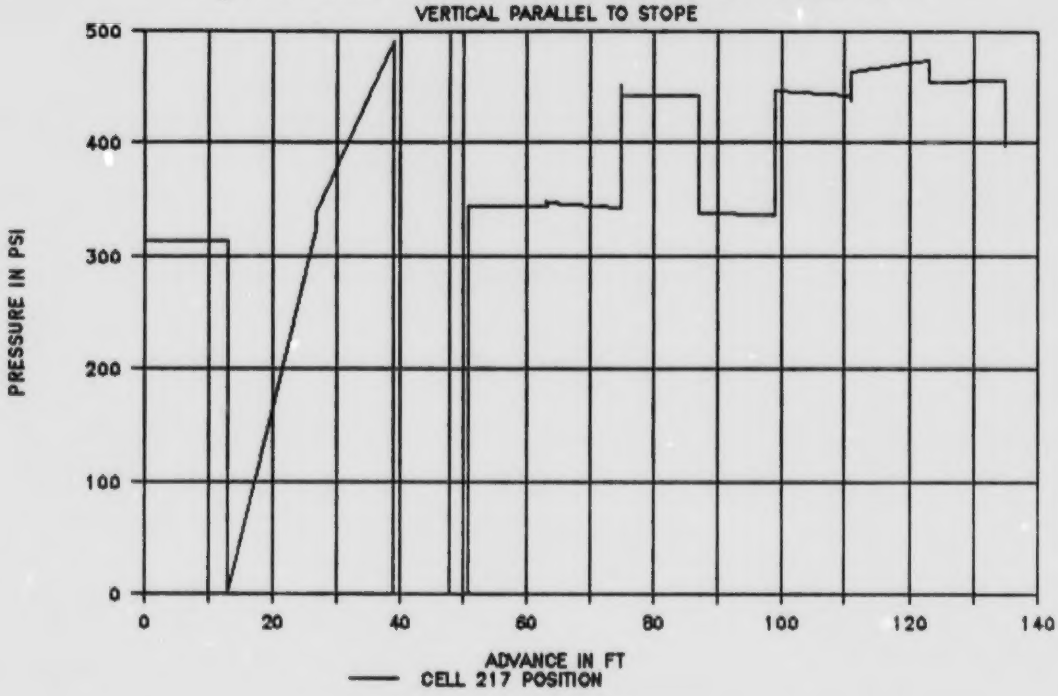


FIGURE 34C EARTH PRESSURE CELL 219

VERTICAL PERPENDICULAR TO STOPE

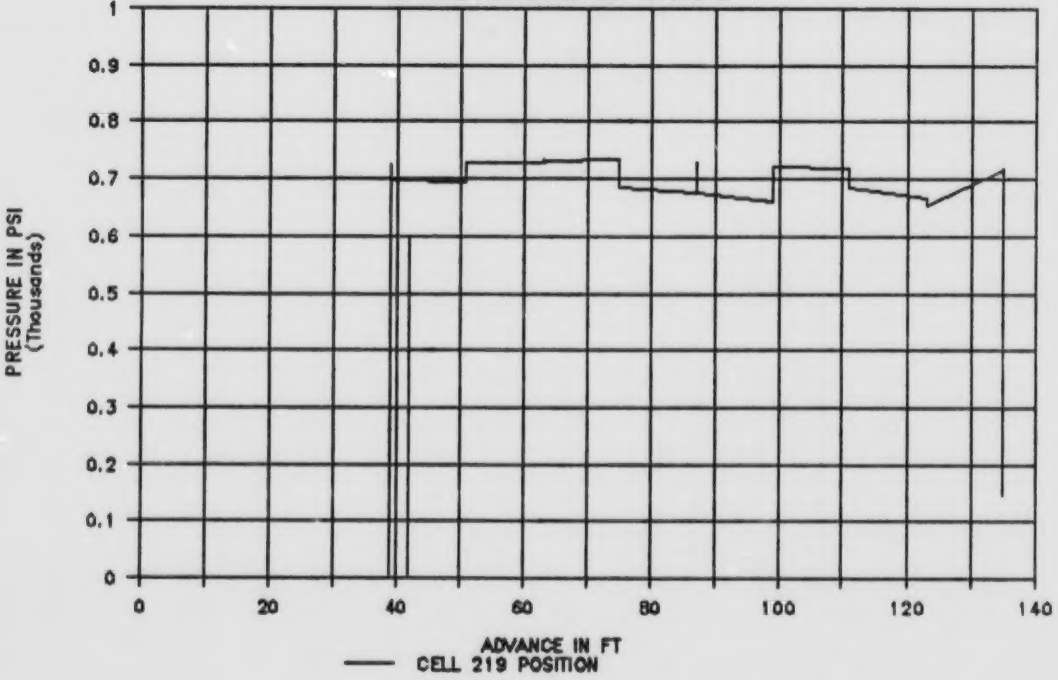


FIGURE 35C EARTH PRESSURE CELL 221

VERTICAL PERPENDICULAR TO STOPE

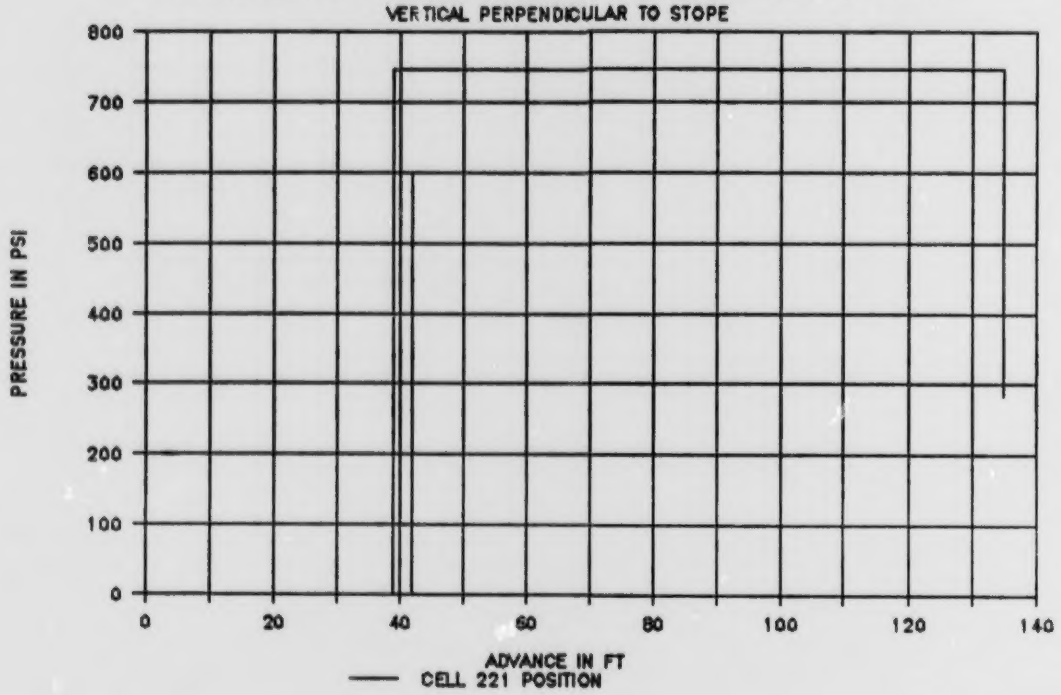


FIGURE 36C EARTH PRESSURE CELL 243

VERTICAL PERPENDICULAR TO STOPE

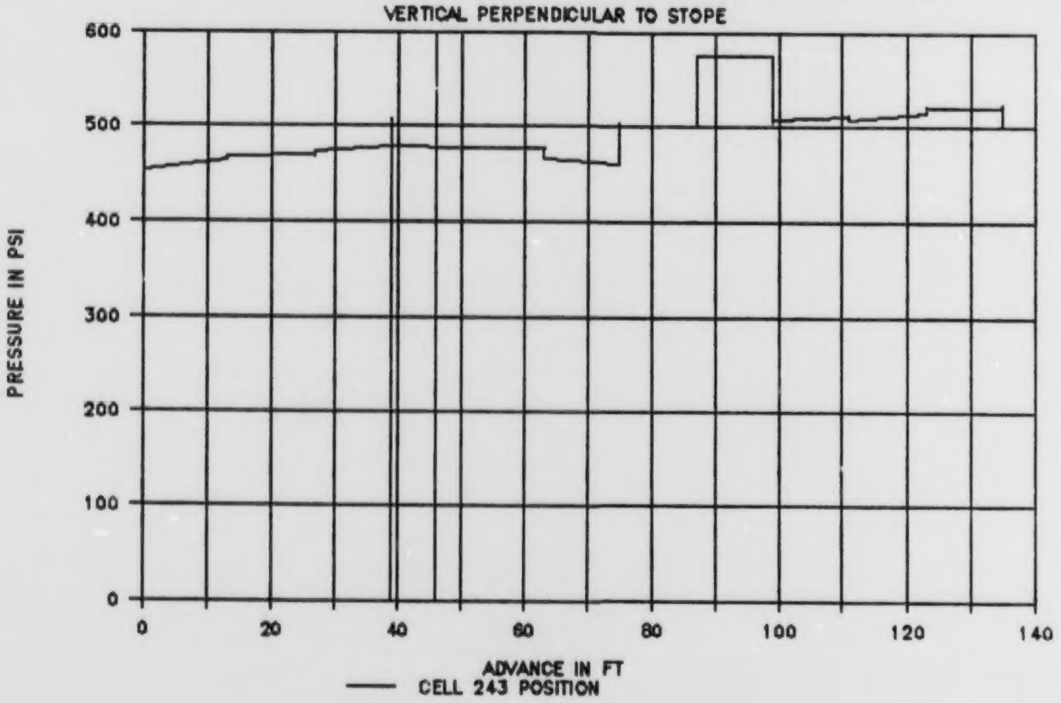


FIGURE 37C CONVERGENCE MONITOR 184

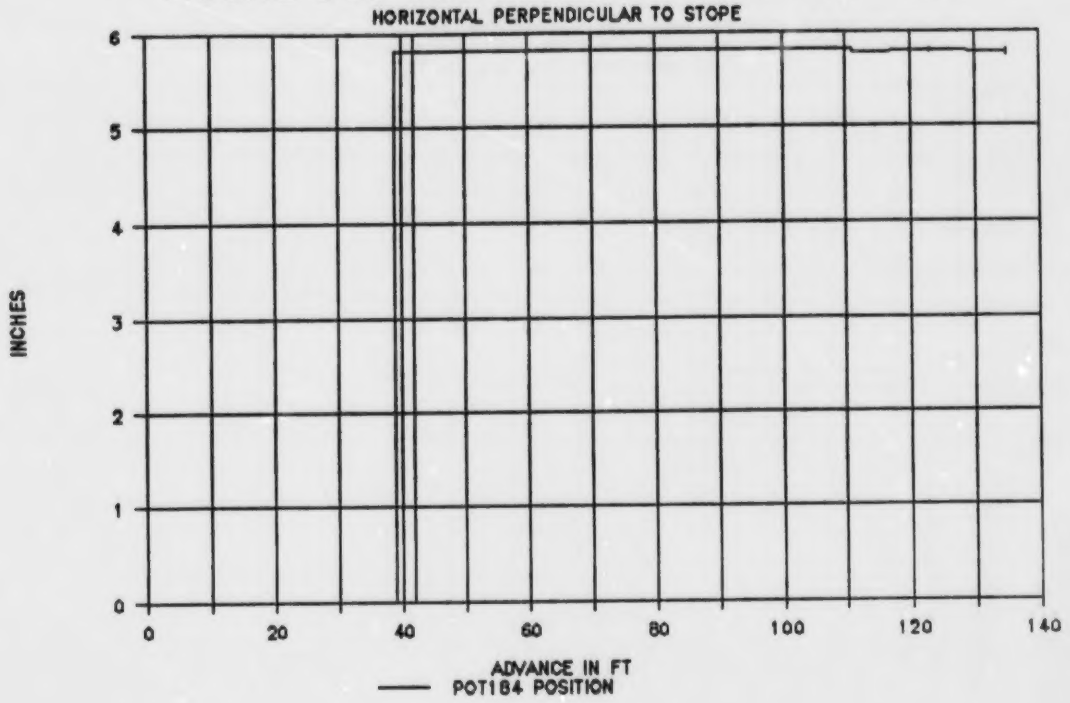


FIGURE 38C CONVERGENCE MONITOR 185

HORIZONTAL PERPENDICULAR TO STOPE

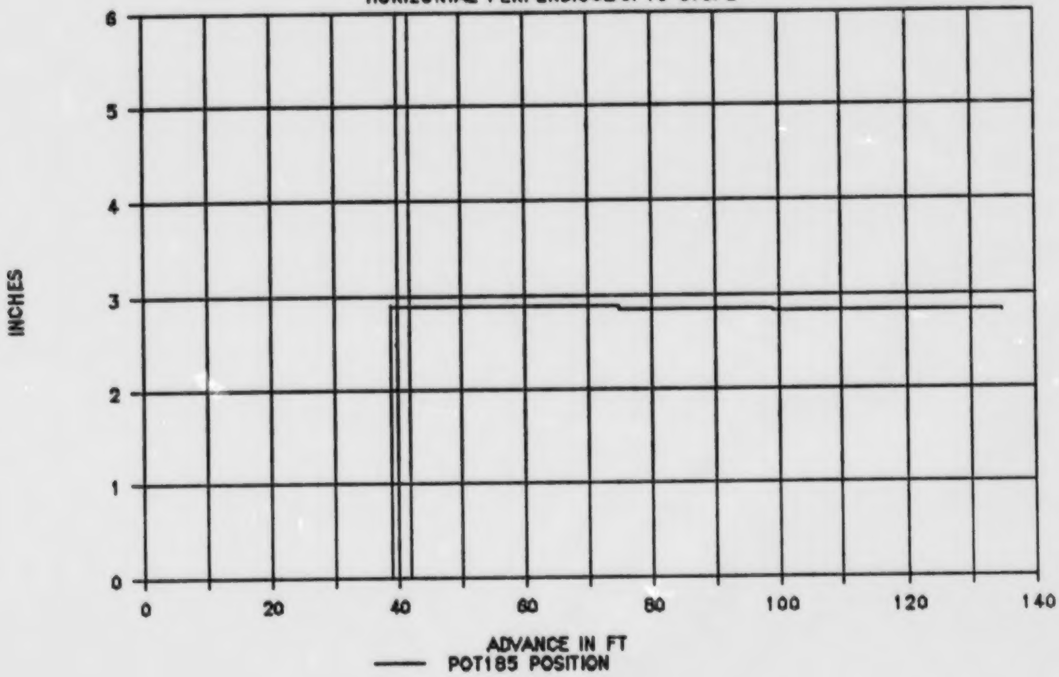


FIGURE 39C CONVERGENCE MONITOR 186

VERTICAL

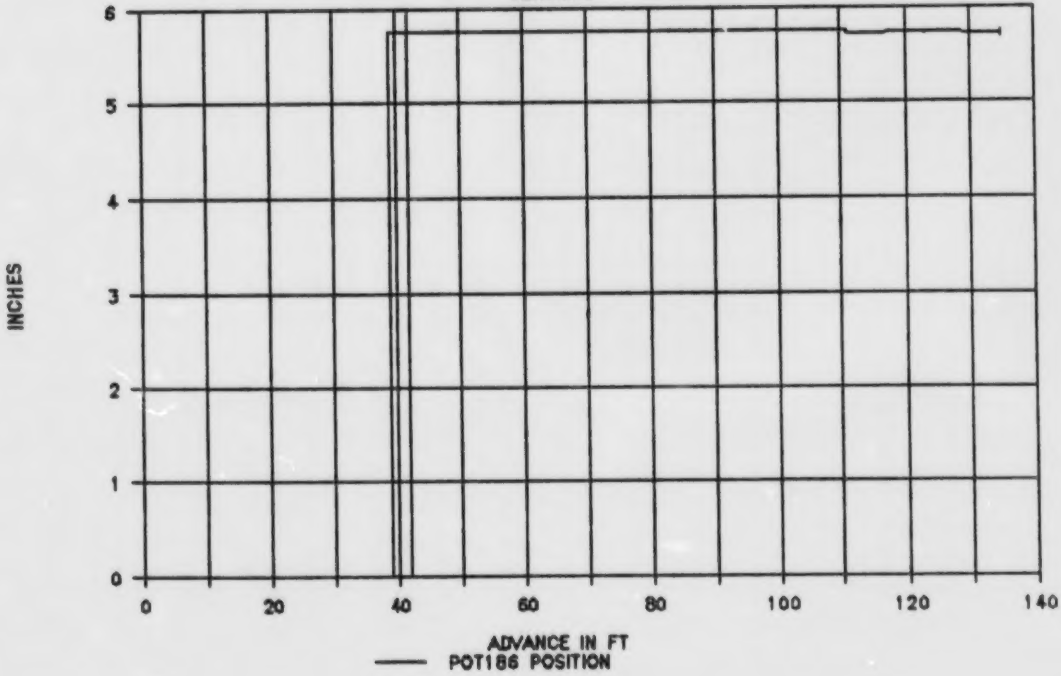


FIGURE 40C CONVERGENCE MONITOR 187

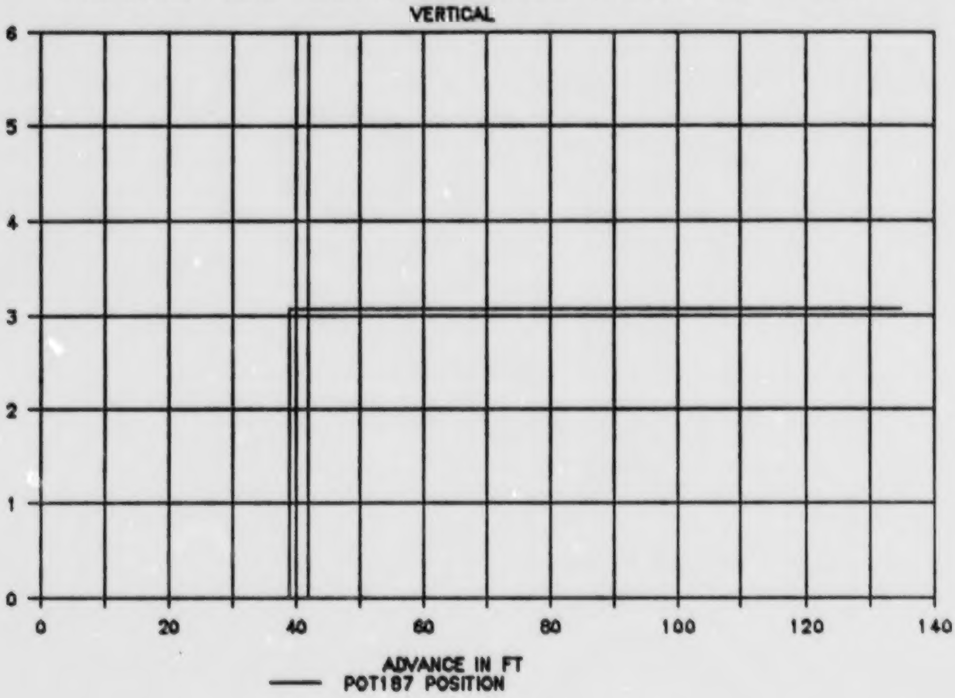


FIGURE 41C CONVERGENCE MONITOR 188

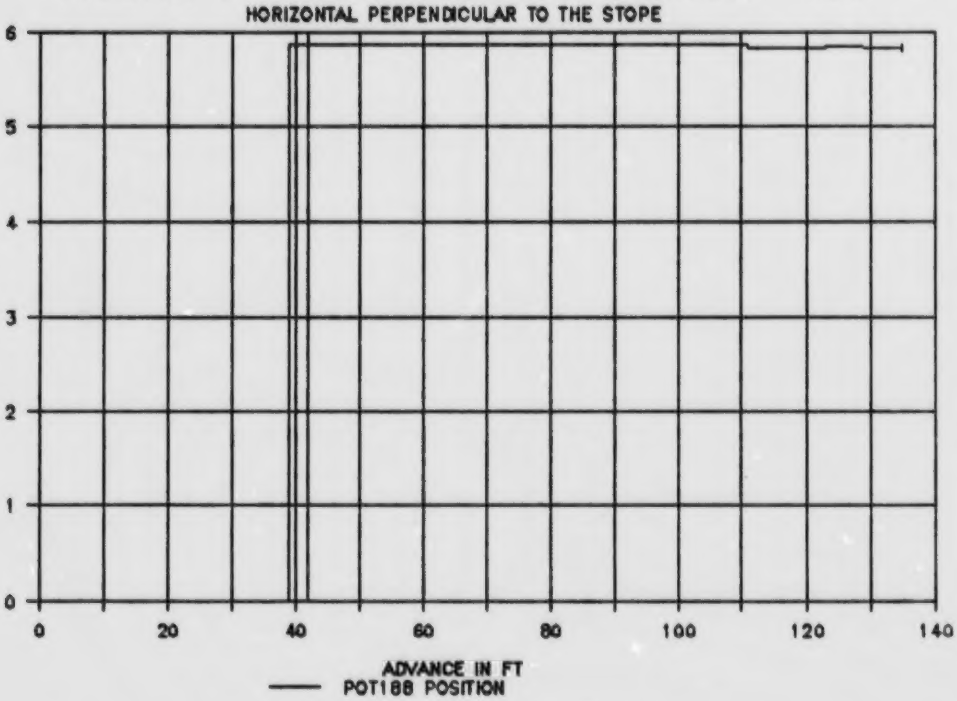


FIGURE 42C CONVERGENCE MONITOR 189

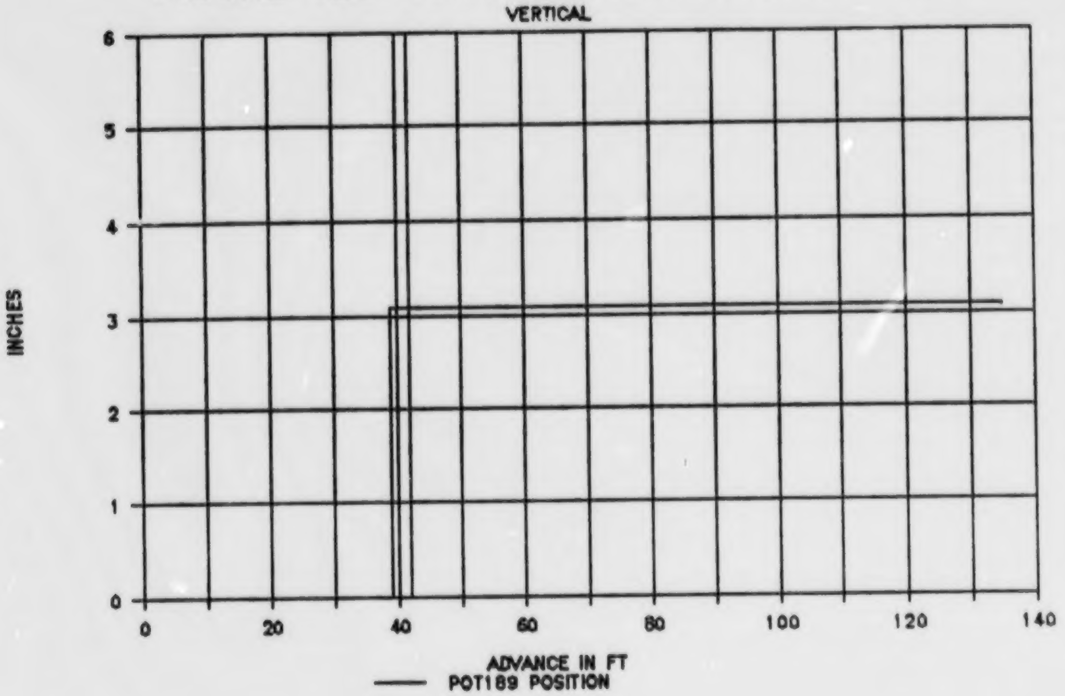

VERTICAL

FIGURE 43C CONVERGENCE MONITOR 190

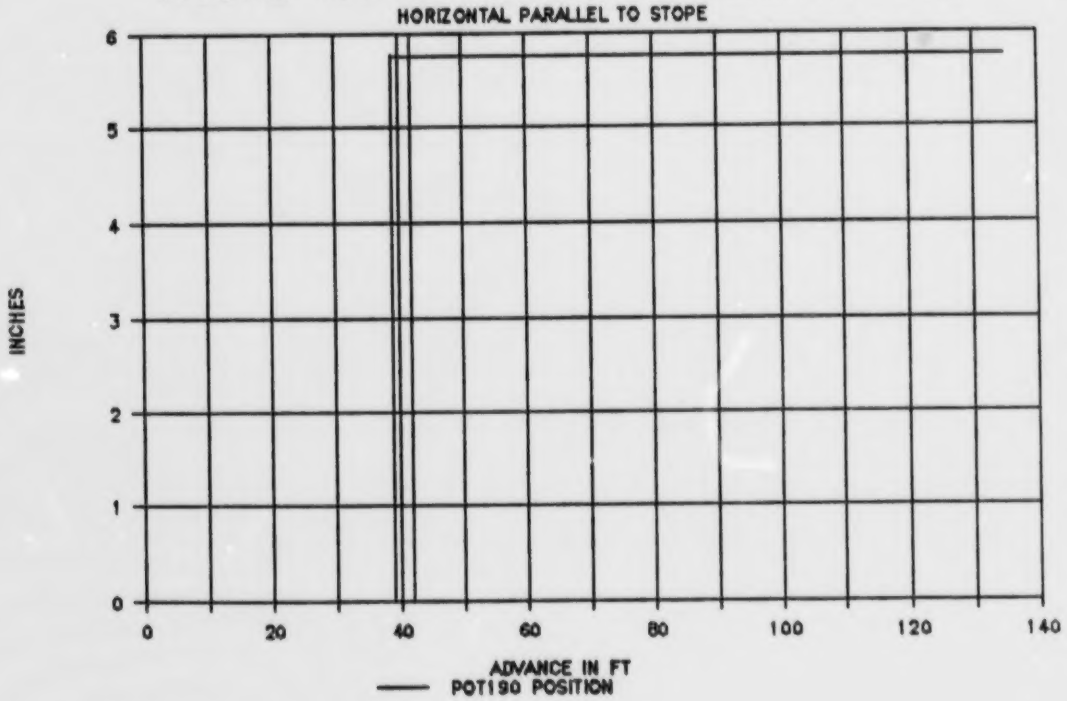

HORIZONTAL PARALLEL TO STOPE

FIGURE 44C THERMISTOR 1

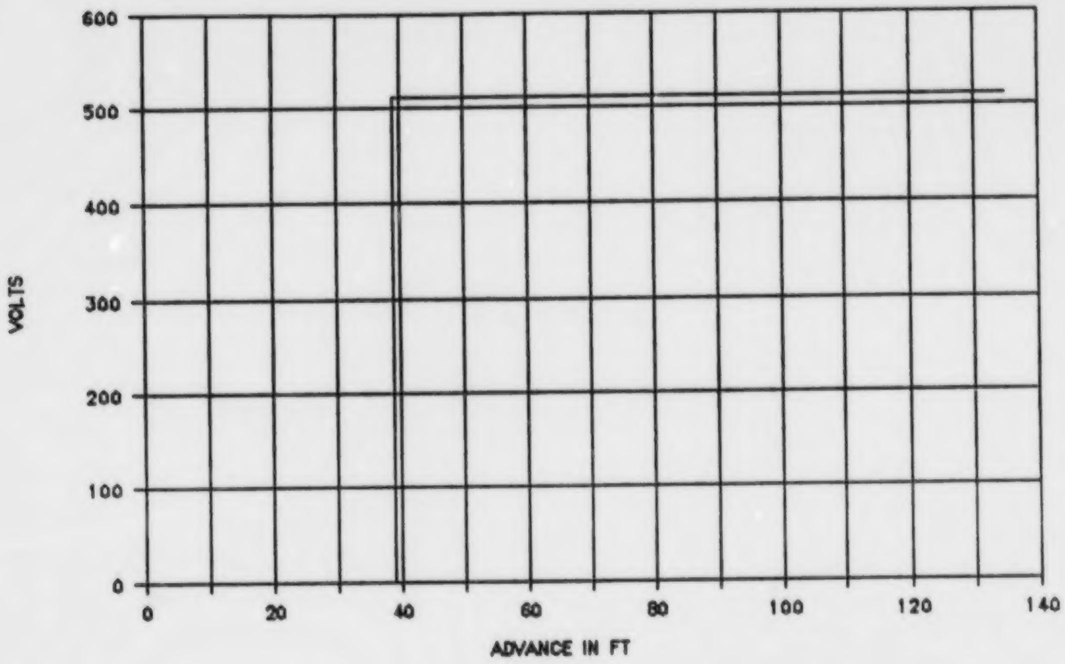


FIGURE 45C THERMISTOR 2

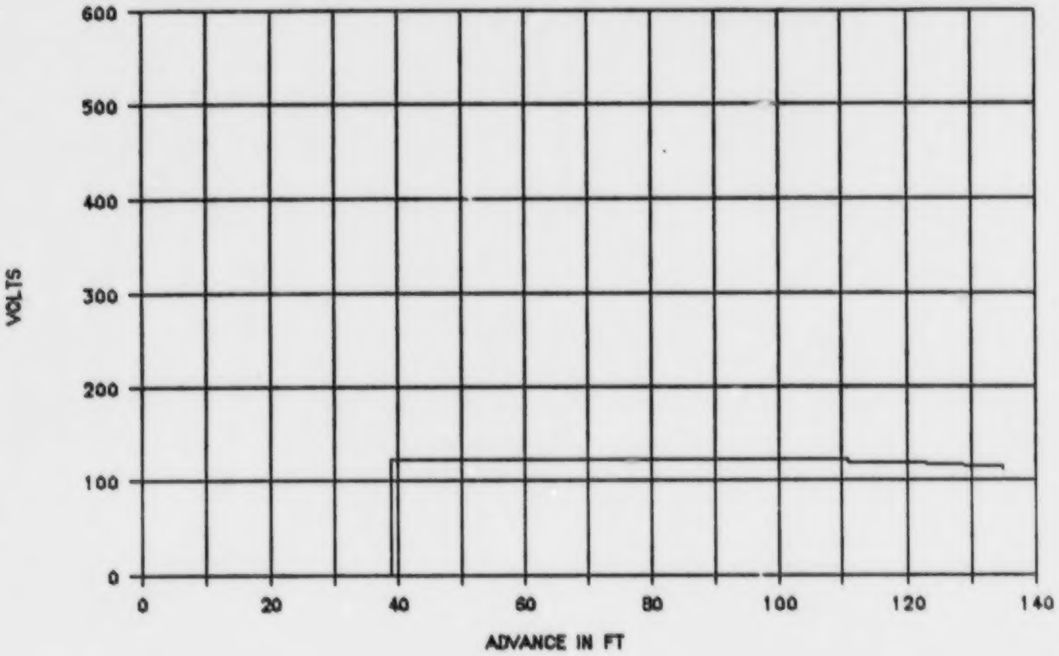


FIGURE 46C THERMISTOR 3

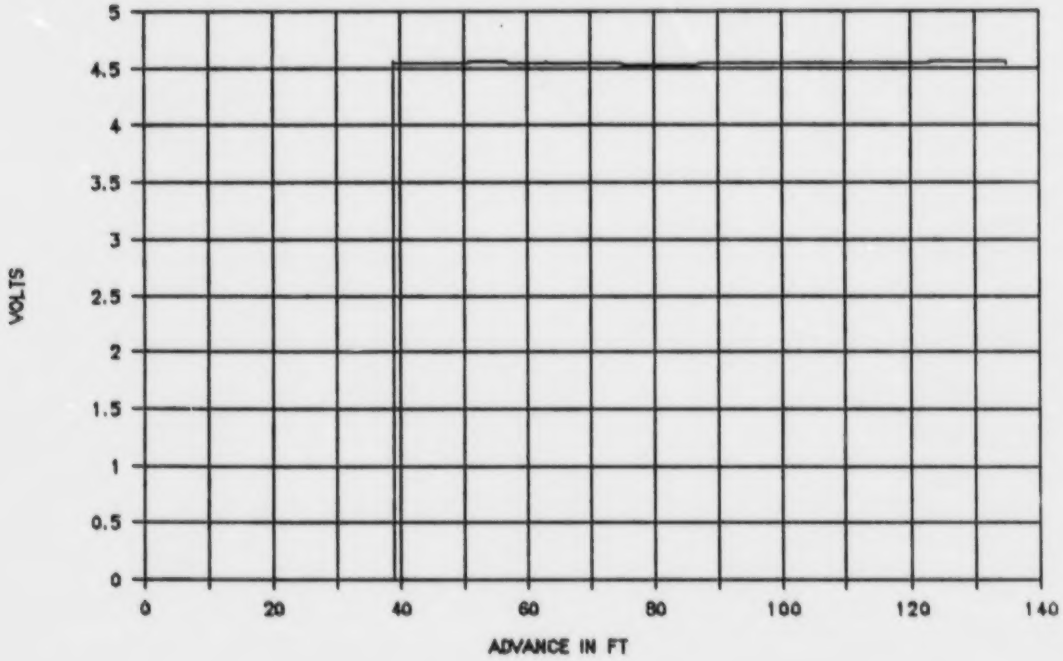


FIGURE 47C THERMISTOR 4

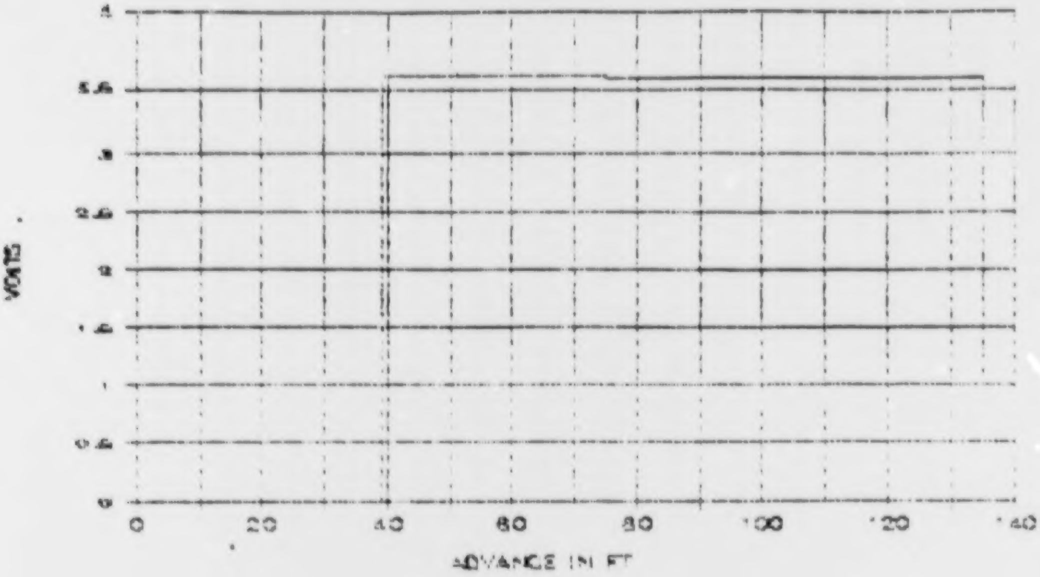


FIGURE 48C PIEZOMETER 1

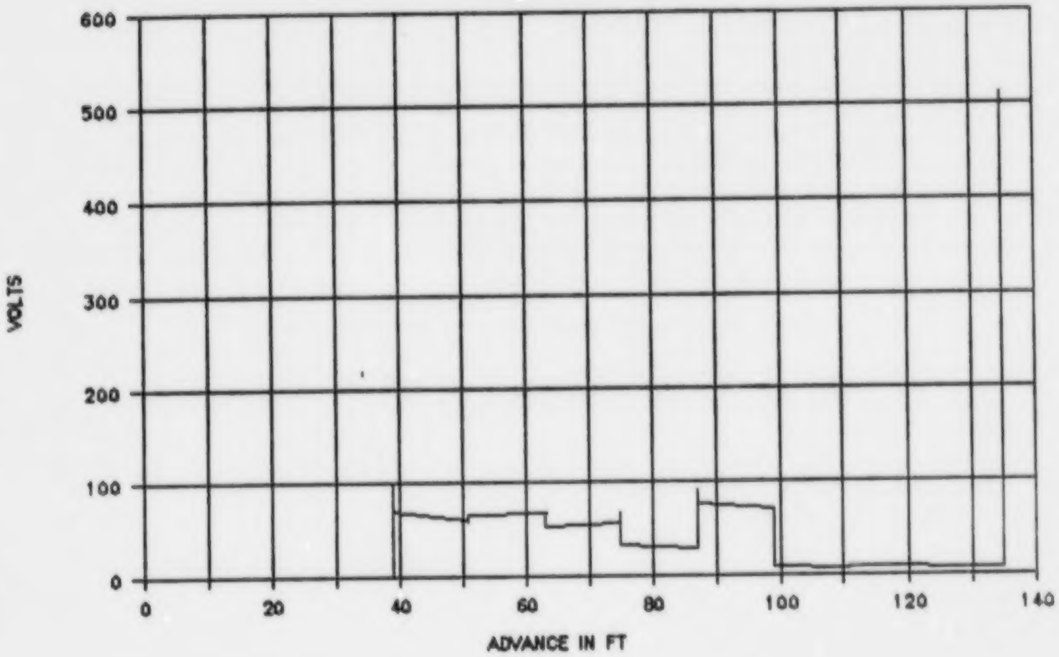


FIGURE 49C PIEZOMETER 2

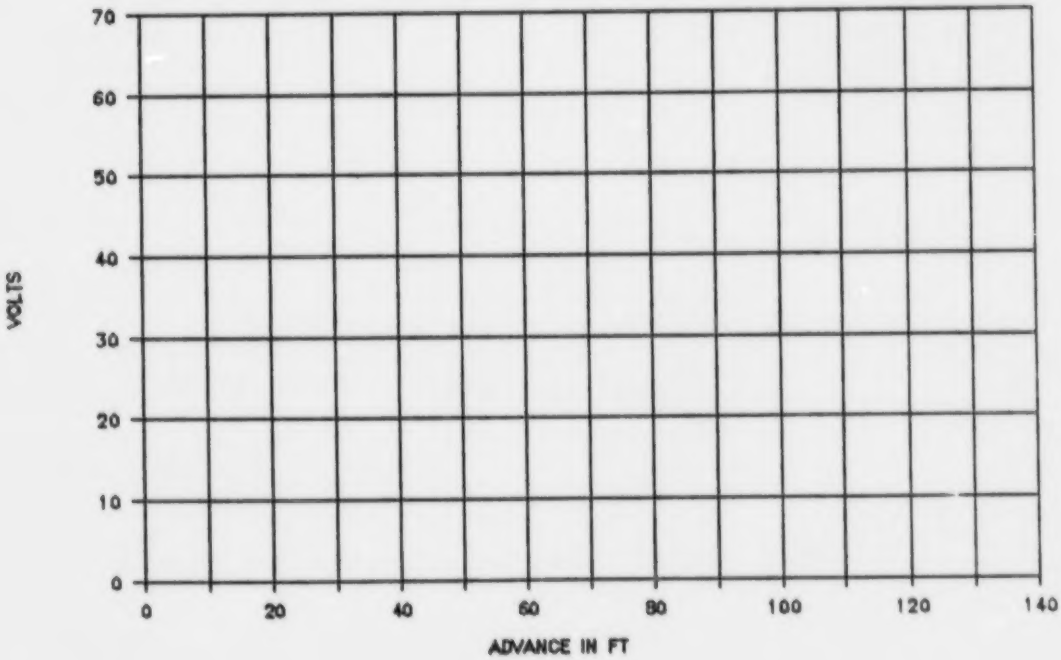
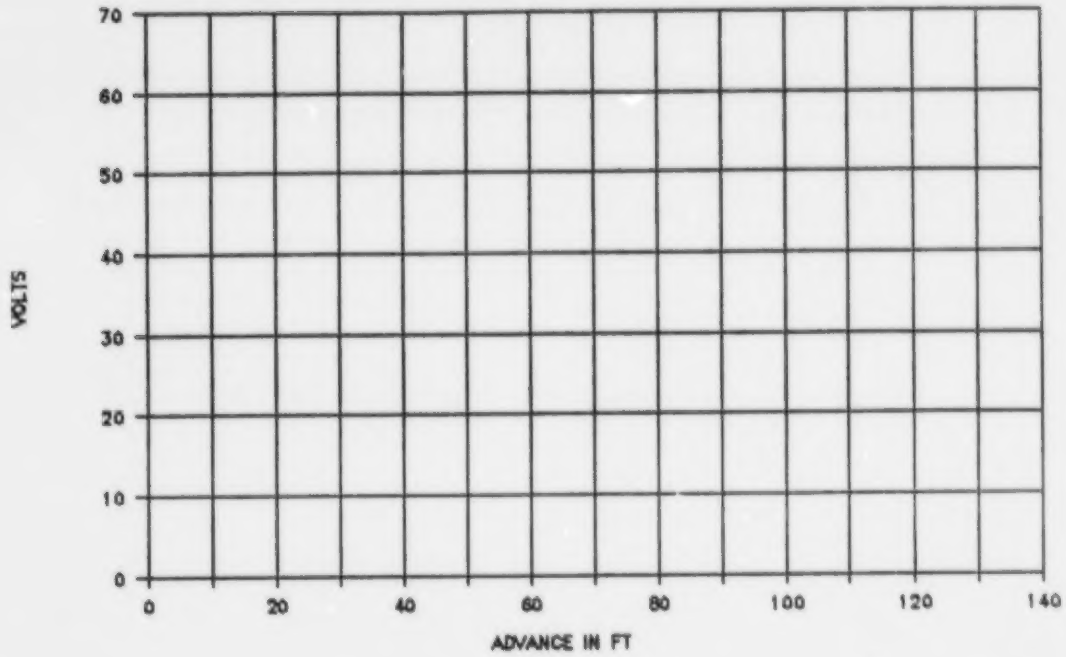


FIGURE 50C PIEZOMETER 3



Young's Modulus Calculation

1) Calculation Using Test Cylinders and In Situ Samples Results

The slope of the elastic proportional limit on a stress-strain diagram was calculated and use as the Young's modulus value of the fill.

2) Calculation Using Young's Modulus Cells Results

The displacement of the Lvtd cell was found in the following manner:

LVTD cells have a displacement of 0.25 inch for 12 volt DC

Therefore $\delta = \frac{0.25 * V}{12}$

Where δ = cell displacement
and V = cell measure voltage

The value were reported on a pressure versus displacement diagram (fig. 50C). The slope of the proportional limit was calculated. Using the uniformally pressurized penny shaped crack theory, which states that:

$$\delta = \frac{8(1 - u^2)RP}{\pi E}$$

Where P = the pressure applied
R = the radius of the cell (e.g. 6 inch)
u = Poisson ratio (assumed to be 0.25)
δ = displacement
and E = Young's modulus.

Thus $1/M = \frac{8(1 - u^2)R}{\pi E}$

Where M = slope of the proportional limit

Therefore $E = \frac{8(1 - u^2)RM}{\pi}$

e. g. the slope of figure 50C is:

$$M = \frac{200 - 0}{0.201 - 0.189} = 16\ 667 \text{ psi/inch}$$

$$E = \frac{8(1 - 0.25^2)(6 \text{ inch}) * 16\ 667 \text{ psi/inch}}{\pi}$$

$$E = 238\ 732 \text{ psi} = 238.73 \text{ ksi}$$

Table 4C
Young Modulus Cells Data

Cell 207

Date	0 psi	100 psi	200 psi	300 psi	350 psi	400 psi
	Displacement in inches					
08/21/87	0.19	0.20	0.20	0.20	0.20	0.20
09/28/87	0.19	0.20	0.20	0.20	0.20	0.20
09/01/87	0.19	0.20	0.20	0.20	0.20	0.20
09/09/87	0.19	0.20	0.20	0.20	0.20	0.20
09/11/87	0.19	0.20	0.20	0.20	0.20	0.20
09/15/87	0.19	0.20	0.20	0.20	0.20	0.20
09/18/87	0.19	0.20	0.20	0.20	0.20	0.20
09/22/87	0.20	0.20	0.21	0.21	0.21	0.21
09/23/87	0.20	0.21	0.21	0.21	0.21	0.21
09/24/87	0.19	0.20	0.20	0.20	0.20	0.21
09/29/87	0.19	0.20	0.20	0.20	0.20	0.20
10/09/87	0.20	0.20	0.20	0.20	0.20	0.20
10/15/87	0.19	0.20	0.20	0.20	0.20	0.20
10/21/87	0.20	0.21	0.21	0.21	0.20	0.20
11/18/87	0.19	0.20	0.20	0.20	0.20	0.20
12/03/87	0.19	0.20	0.20	0.20	0.20	0.20
12/10/87	0.19	0.20	0.20	0.20	0.20	0.20
01/08/88	0.19	0.20	0.20	0.20	0.20	0.20
01/19/88	0.20	0.20	0.20	0.20	0.20	0.20

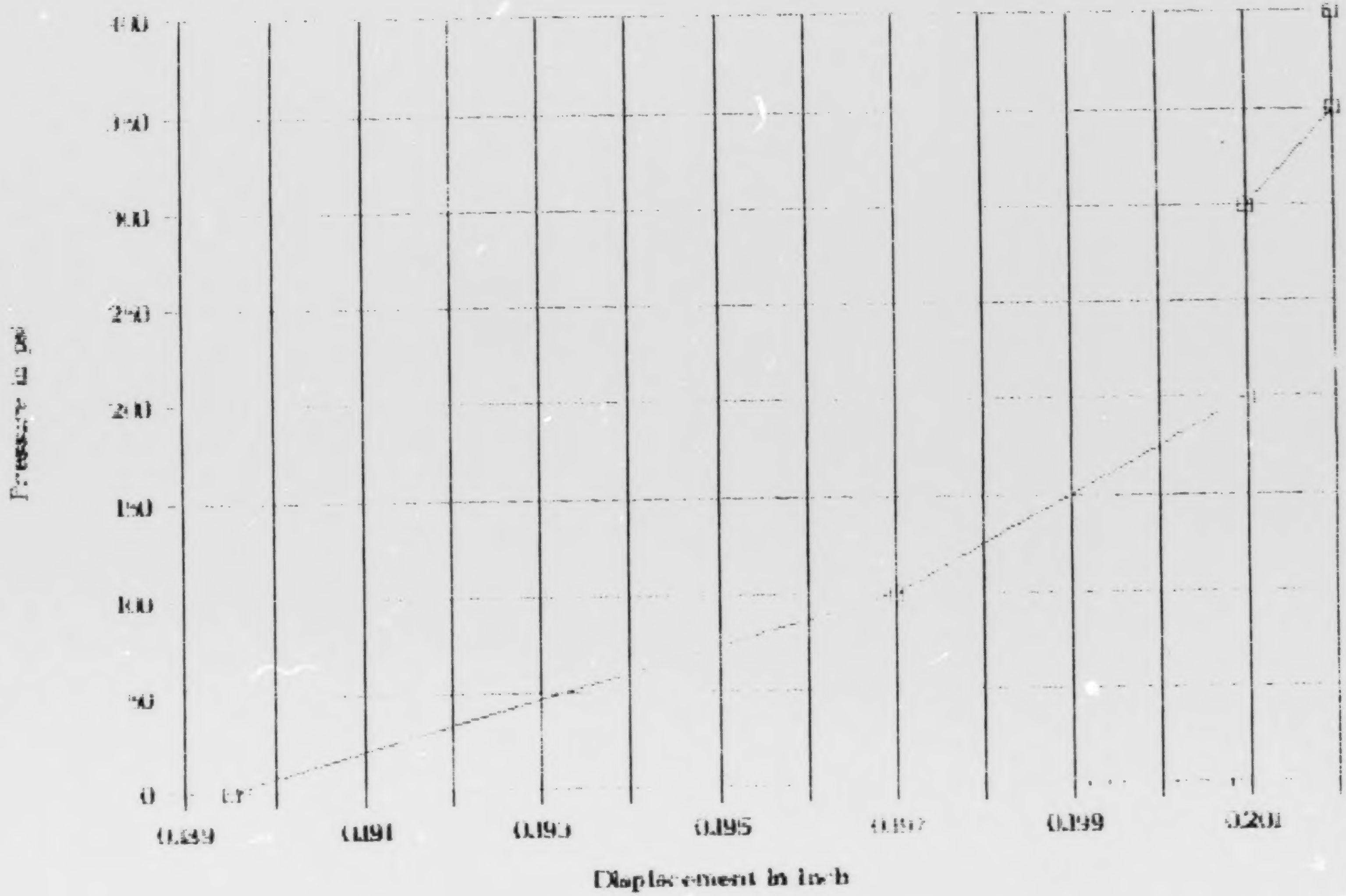
Table 4C (continued)

Cell 208

Displacement in inches

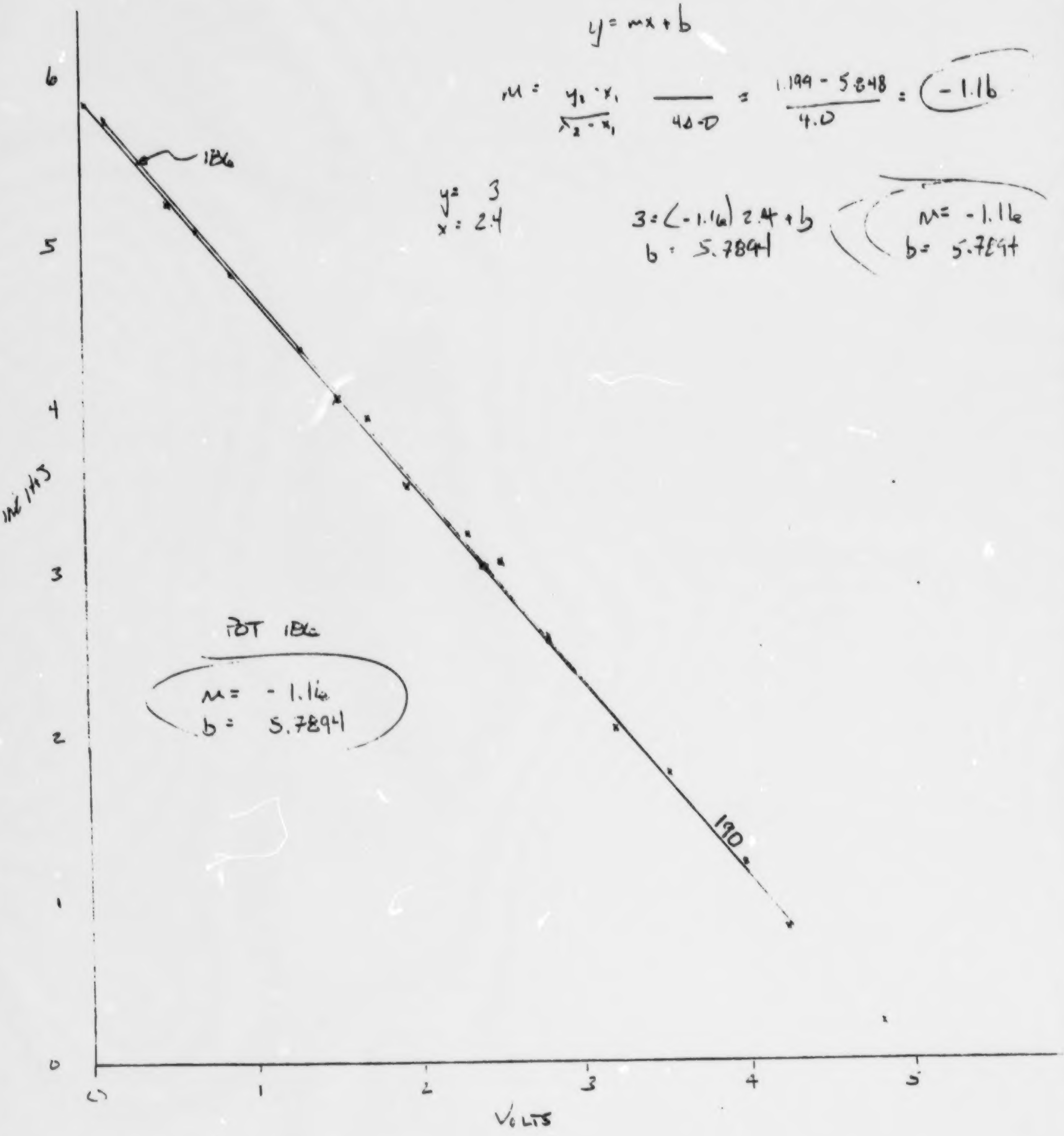
Date	0 psi	100 psi	200 psi	300 psi	350 psi	400 psi
08/21/87	0.14	0.15	0.15	0.15	0.15	0.15
09/28/87	0.14	0.15	0.15	0.15	0.15	0.15
09/01/87	0.14	0.15	0.15	0.15	0.15	0.15
09/09/87	0.14	0.15	0.15	0.15	0.15	0.15
09/11/87	0.14	0.15	0.15	0.15	0.15	0.15
09/15/87	0.14	0.14	0.14	0.14	0.14	0.14
09/18/87	0.14	0.14	0.15	0.15	0.15	0.1[illegible]
09/22/87	0.14	0.14	0.14	0.14	0.14	0.14
09/23/87	0.15	0.15	0.15	0.15	0.15	0.15
09/24/87	0.15	0.15	0.15	0.15	0.15	0.15
09/29/87	0.14	0.15	0.15	0.15	0.15	0.15
10/09/87	0.14	0.14	0.15	0.15	0.15	0.15
10/15/87	0.14	0.15	0.15	0.15	0.15	0.1[illegible]
10/21/87	0.14	0.14	0.14	0.14	0.14	0.14
11/18/87	0.14	0.14	0.14	0.14	0.15	0.15
12/03/87	0.14	0.14	0.15	0.15	0.15	0.15
12/10/87	0.14	0.15	0.15	0.15	0.15	0.15
01/08/88	0.14	0.14	0.15	0.15	0.15	0.15
01/19/88	0.14	0.14	0.14	0.14	0.14	0.14

Pressure vs Displacement



Calibration Curve

Pot. 190



$y = mx + b$

$m = \frac{y_2 - y_1}{x_2 - x_1} \quad \frac{\qquad}{4.0 - 0} = \frac{1.199 - 5.848}{4.0} = \boxed{-1.16}$

$y = 3$
$x = 2.4$

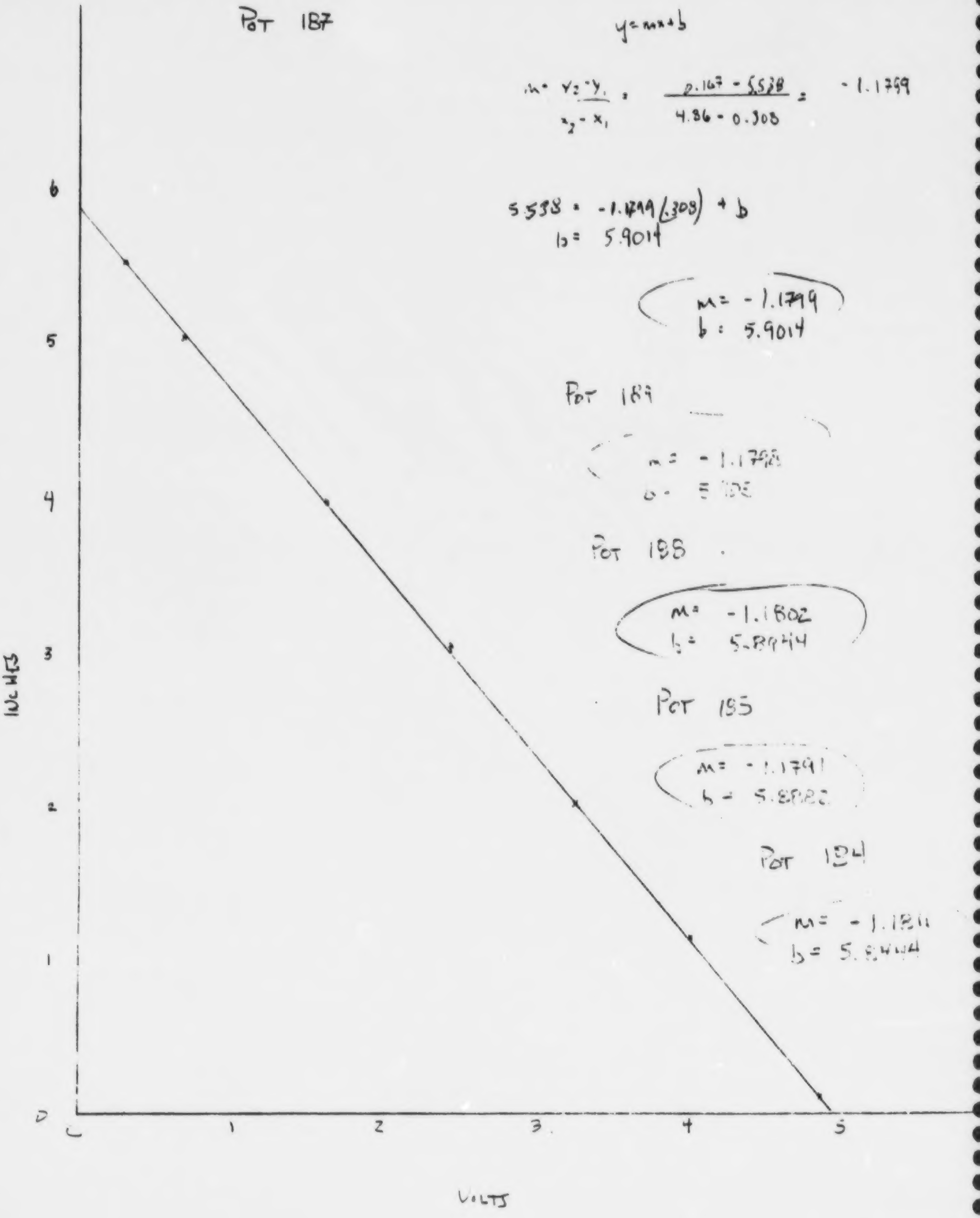
$3 = (-1.16)\,2.4 + b$
$b = 5.7894$

$m = -1.16$
$b = 5.7894$

POT 186

$m = -1.16$
$b = 5.7894$

POT 187



$y = mx + b$

$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0.167 - 5.538}{4.86 - 0.308} = -1.1799$

$5.538 = -1.1799(.308) + b$

$b = 5.9014$

$m = -1.1799$

$b = 5.9014$

POT 189

$m = -1.1798$

$b = 5.$[illegible]

POT 188

$m = -1.1802$

$b = 5.8944$

POT 185

$m = -1.1791$

$b = 5.8882$

POT 184

$m = -1.1811$

$b = 5.8444$

DATE: January 2, 1987

S.N.: 00176

KIPS	#1	#2	#3	#4	AVERAGE
0	8.3	8.3	8.3	8.3	8.3
10	13.5	13.6	13.5	13.5	13.53
20	29.8	29.8	29.8	29.7	29.78
30	57.5	57.5	57.6	57.5	57.53
40	94.6	94.6	94.7	94.7	94.65

$y = b + a \ln x$

$a = 214.3$

$b = -389.3$

DATE: January 2, 1987

S.N.: 00177

KIPS	#1	#2	#3	#4	AVERAGE
0	7.7	7.8	7.8		7.73
10	9.6	9.7	9.7		9.67
20	24.3	24.7	24.6		24.53
30	55.3	55.5	55.4		55.40
40	96.0	96.0	95.6		95.87

$y = b + a \ln x$

$a = 230.8$

$b = -423.7$

DATE: January 2, 1987

S.N.: 00178

KIPS	#1	#2	#3	#4	AVERAGE
0	9.0	9.0	9.0		9.0
10	55.5	55.4	55.3		55.40
20	101.0	99.8	99.7		100.17
30	142.7	142.7	142.7		142.7
40					

$y = b + a \ln x$

$a = 176.5$

$b = -452.9$

DATE: January 2, 1987

S.N.: 00179

KIPS	#1	#2	#3	#4	AVERAGE
0	8.2	8.2	8.2		8.2
10	12.9	13.1	12.9		12.97
20	39.1	38.9	38.8		38.93
30	77.4	77.9	77.2		77.50
40	122.0	121.6	121.4		121.67

$y = b + a \ln x$

$a = 222.2$

$b = 455.6$

DATE: January 2, 1987

S.N.: 00180

KIPS	#1	#2	#3	#4	AVERAGE
0	7.6	7.6	7.6		7.6
10	44.8	44.9	45.2		44.97
20	88.9	89.3	89.3		89.17
30	132.9	132.6	133.3		132.93
40					

$y = b + a \ln x$

$a = 162.2$

$b = -367.6$

DATE: January 2, 1987

S.N.: 00181

KIPS	#1	#2	#3	#4	AVERAGE
0	8.7	8.7	8.7		8.7
10	12.3	12.3	12.3		12.3
20	33.9	34.0	34.1		34.0
30	69.8	69.7	69.6		69.70
40	114.3	114.6	114.6		114.50

$y = b + a \ln x$

$a = 230.8$

$b = -434.6$

DATE: January 2, 1987

S.N.: 00182

KIPS	#1	#2	#3	#4	AVERAGE
0	8.3	8.3	8.3		8.3
10	9.7	9.7	9.7		9.7
20	18.8	19.1	18.9		18.93
30	47.3	47.2	47.2		47.23
40	86.2	86.3	86.4		86.3

$y = b + a \ln x$

$a = 243.9$

$b = -426.8$

DATE: January 2, 1987

S.N.: 00183

KIPS	#1	#2	#3	#4	AVERAGE
0	7.9	7.9	7.9	7.9	7.9
10	9.9	9.8	9.8	9.8	9.8
20	23.9	24.1	24.2	24.5	24.2
30	54.6	54.8	54.9	54.7	54.8
40	94.9	95.4	95.7	95.6	95.4

$y = b + a \ln x$

$a = 209.8$

$b = -349.7$

DATE: January 2, 1987

S.N.: 00184

KIPS	#1	#2	#3	#4	AVERAGE
0	7.5	7.5	7.5	7.5	7.5
10	9.7	9.7	9.7	9.7	9.7
20	20.4	20.5	20.4	20.3	20.4
30	47.4	47.1	47.3	47.4	47.3
40	85.1	85.0	85.1	84.9	85.0

$y = b + a \ln x$

$a = 267.9$

$b = -509.8$

DATE: January 2, 1987

S.N.: 00185

KIPS	#1	#2	#3	#4	AVERAGE
0	9.5	9.5	9.5	9.5	9.5
10	13.5	13.4	13.4	13.6	13.5
20	27.0	27.1	27.1	27.4	27.2
30	51.5	51.8	51.8	51.9	51.8
40	87.8	88.0	88.4	88.4	88.2

$y = b + a \ln x$

$a = 260.9$

$b = 543.5$

DATE: January 2, 1987

S.N.: 00187

KIPS	#1	#2	#3	#4	AVERAGE
0	8.0	8.0	8.0	8.0	8.0
10	25.1	25.3	25.3	25.4	25.3
20	53.5	53.6	53.4	53.7	53.6
30	89.8	89.8	89.5	89.8	89.7
40	131.6	131.6	131.3	131.1	131.4

$y = b + a \ln x$

$a = 191.1$

$b = -436.3$

DATE: January 2, 1987

S.N.: 00189

KIPS	#1	#2	#3	#4	AVERAGE
0	8.2	8.2	8.2	8.2	8.2
10	16.3	16.3	16.4	17.1	16.5
20	41.3	41.3	41.3	41.1	41.3
30	77.7	77.8	77.5	77.4	77.6
40	120.1	120.0	120.1	120.1	120.1

$y = b + a \ln x$

$a = 236.2$

$b = -520.5$

DATE: January 2, 1987

S.N.: 00190

KIPS	#1	#2	#3	#4	AVERAGE
0	8.1	8.1	8.1	8.1	8.1
10	20.4	20.8	20.7	21.0	20.7
20	55.8	56.1	55.8	56.4	56.0
30	98.1	98.5	98.4	99.0	98.5
40					

$y = b + a \ln x$

$a = 193.6$

$b = -429.0$

DATE: January 2, 1987

S.N.: 00191

KIPS	#1	#2	#3	#4	AVERAGE
0	8.2	8.3	8.3	8.3	8.3
10	15.0	15.0	15.0	15.0	15.0
20	40.7	40.7	40.5	40.7	40.7
30	77.6	77.3	77.1	77.1	77.3
40	118.1	118.0	118.3	118.3	118.2

$Y = b \cdot a \ln$

$a = 214.3$

$b = -453.6$

DATE: January 2, 1986

S.N.: 00192

KIPS	#1	#2	#3	#4	AVERAGE
0	8.4	8.4	8.4	8.4	8.4
10	10.9	11.0	11.0	11.0	11.0
20	27.1	27.0	26.7	26.9	26.9
30	57.7	57.6	57.7	57.6	57.6
40	98.6	98.6	98.4	98.5	98.5

$y = b + a \ln x$

$a = 230.8$

$b = -446.2$

DATE: January 2, 1987

S.N.: 00194

KIPS	#1	#2	#3	#4	AVERAGE
0	8.3	8.3	8.3	8.3	8.3
10	9.8	9.8	9.8	9.8	9.8
20	19.7	19.8	19.8	19.7	19.7
30	45.3	45.5	45.2	45.2	45.3
40	81.7	81.6	81.4	81.6	81.6

$y = b + a \ln x$

$a = 250.0$

$b = -475.0$

DATE: January 2, 1987

S.N.: 00195

KIPS	#1	#2	#3	#4	AVERAGE
0	6.4	6.4	6.4	6.4	6.4
10	8.7	8.8	8.7	8.7	8.7
20	32.8	32.6	32.4	32.4	32.6
30	74.8	74.5	74.5	74.5	74.6
40	122.8	122.4	122.4	122.3	122.5

$y = b + a\,l.x$

$a = 181.8$

$b = -272.7$

DATE: January 2, 1987

S.N.: 00198

KIPS	#1	#2	#3	#4	AVERAGE
0	8.0	8.0	8.0	8.0	8.0
10	11.7	11.6	11.6	11.5	11.6
20	32.3	31.9	31.9	31.5	31.9
30	67.8	67.3	67.3	67.1	67.4
40	112.2	112.4	112.4	112.6	112.4

$y = b + a \ln x$

$a = 230.8$

$b = -446.2$

DATE: January 2, 1987

S.N.: 00199

KIPS	#1	#2	#3	#4	AVERAGE
0	7.8	7.8	7.8	7.8	7.8
10	9.2	9.2	9.2	9.2	9.2
20	24.3	23.5	23.5	23.1	23.6
30	58.1	57.7	57.3	57.2	57.6
40	102.0	101.5	101.5	101.2	101.6

$y = b + ax$

$a = 240.0$

$b = -472.0$

DATE: January 2, 1987

S.N.: 00200

KIPS	#1	#2	#3	#4	AVERAGE
0	8.0	8.0	8.0	8.0	8.0
10	29.7	30.2	30.2	30.4	30.1
20	71.1	69.7	69.9	70.1	70.2
30	112.2	111.9	112.0	112.0	112.0
40					

Value in psi $y = a + b \ln x$

$a = -393.6$

$b = 182.4$

DATE: January 2, 1987

S.N.: 00201

KIPS	#1	#2	#3	#4	AVERAGE
0	8.1	8.1	8.1	8.1	8.1
10	11.3	11.3	11.3	11.3	11.3
20	27.0	26.8	26.9	26.9	26.9
30	55.4	55.2	55.3	55.1	55.2
40	94.9	95.0	95.2	94.7	95.0

$y = b + a \ln x$

$a = 211.3$

$b = -381.0$

DATE: January 2, 1986

S.N.: 00202

KIPS	#1	#2	#3	#4	AVERAGE
0	8.0	8.0	8.0		8.0
10	11.6	11.6	11.6		11.6
20	34.6	34.9	34.5		34.7
30	75.4	75.3	75.1		75.3
40	121.4	121.2	121.3		121.3

$y = b + a | x$

$a = 200.0$

$b = -380.0$

DATE: January 2, 1987

S.N.: 00203

KIPS	#1	#2	#3	#4	AVERAGE
0	7.9	7.9	7.9		7.9
10	10.2	10.1	10.1		10.1
20	23.8	23.7	23.8		23.8
30	54.7	54.7	54.8		54.7
40	97.5	97.4	97.5		97.5

$y = b + a \ln x$

$a = 230.8$

$b = -457.7$

DATE: January 2, 1987

S.N.: 00205

KIPS	#1	#2	#3	#4	AVERAGE
0	7.7	7.7	7.7	7.7	7.7
10	9.9	10.1	9.9	9.9	10.0
20	29.7	30.0	29.2	29.3	29.6
30	65.3	65.1	64.8	64.8	65.0
40	109.0	109.0	108.9	108.9	108.9

$y = b + a \ln x$

$a = 206.9$

$b = 358.6$

DATE: January 2, 1987

S.N.: 00206

KIPS	#1	#2	#3	#4	AVERAGE
0	8.1	8.1	8.1	8.1	8.1
10	10.7	10.7	10.7	10.7	10.7
20	26.6	26.2	26.2	26.1	26.3
30	56.9	56.9	56.7	56.9	56.9
40	98.0	98.2	98.2	98.5	98.2

$y = b + a \ln x$

$a = 250.0$

$b = -512.5$

DATE: January 2, 1987

S.N.: 00213

KIPS	#1	#2	#3	#4	AVERAGE
0	8.1	8.0	8.0	8.1	8.0
10	11.9	12.0	11.9	12.0	11.9
20	24.6	24.8	24.7	24.9	24.7
30	49.5	49.8	49.5	49.4	49.6
40	85.0	85.2	85.2	85.3	85.2

$y = b + a \ln x$

$a = 245.9$

$b = 476.2$

DATE: January 2, 1987

S.N.: 00214

KIPS	#1	#2	#3	#4	AVERAGE
0	7.8	7.8	7.8	7.9	7.8
10	18.1	18.4	18.5	18.5	18.4
20	47.7	47.8	48.1	48.3	48.0
30	85.2	85.5	85.4	85.6	85.4
40	125.1	125.2	125.5	125.4	125.3

$y = b + a \ln x$

$a = 219.0$

$b: 485.4$

DATE: January 2, 1987

S.N.: 00215

KIPS	#1	#2	#3	#4	AVERAGE
0	7.9	7.9	7.9	7.9	7.9
10	22.8	22.8	23.0	23.0	22.9
20	53.4	53.6	53.5	53.4	53.5
30	90.9	90.9	90.9	90.8	90.9
40	130.9	130.7	130.7	130.7	130.7

$y = b + a\,lx$

$a = 230.8$

$b = 538.5$

DATE: January 2, 1987

S.N.: 00216

KIPS	#1	#2	#3	#4	AVERAGE
0	7.9	7.9	7.9	7.9	7.9
10	12.1	12.0	12.0	12.1	12.0
20	26.2	26.0	26.0	26.0	26.0
30	50.5	50.5	50.5	50.3	50.5
40	86.4	86.4	86.1	86.0	86.2

$y = b + a \ln x$

$a = 234.4$

$b = -444.6$

DATE: January 2, 1987

S.N.: 00217

KIPS	#1	#2	#3	#4	AVERAGE
0	9.0	9.0	9.0	9.0	9.0
10	50.7	51.2	51.2	51.4	51.1
20	93.2	93.2	93.1	93.3	93.2
30	133.3	133.2	133.3	133.3	133.3
40					

$y = b + a \ln x$

$a = 176.5$

$b = -435.3$

DATE: January 2, 1987

S.N.: 00219

KIPS	#1	#2	#3	#4	AVERAGE
0	7.7	7.7	7.7	7.7	7.7
10	13.3	13.4	13.4	13.3	13.3
20	32.3	32.6	32.4	32.4	32.4
30	66.6	66.9	66.1	66.8	66.6
40	108.8	108.6	108.3	108.3	108.4

$Y = b + a \ln x$

$a = 230.8$

$b = -457.7$

DATE: January 2, 1987

S.N.: 00221

KIPS	#1	#2	#3	#4	AVERAGE
0	8.1	8.1	8.1	8.0	8.0
10	29.5	29.5	29.5	29.5	29.5
20	60.1	60.1	60.0	60.2	60.1
30	94.2	94.0	94.0	93.9	94.0
40					

$y = b + a \ln x$

$a = 184.1$

$b = -401.8$

DATE: January 2, 1987

S.N.: 00243

KIPS	#1	#2	#3	#4	AVERAGE
0	0.7	0.7	0.7	0.7	0.7
10	7.8	8.0	8.2	8.3	8.3
20	35.7	36.5	36.6	36.3	36.3
30	70.6	70.9	71.6	71.3	71.1
40	110.9	111.6	112.2	111.8	111.6

$y = b + a \ln x$

$a = 125.00$ $a =$

$b =$

$b = -43.8$

APPENDIX "D"

The procedure for fill room preparation was as follows:

1) Spread and level two feet of fine muck on the floor keeping the corners square.

2) Lay water tight fabrene on the levelled muck, overlap joints.

3) Lay two layers of number nine wire screen on the fabrene, one layer longitudinal and one layer transverse and extend the screen four feet up the walls.

4) Install eight foot rebars vertically, three per row, one row every six feet. These rebars were used to support and position the instrumentation inside the test stope.

5) Install two, four inch steel sandfill lines along the back, one to the mid-point and one to the end of the slice.

6) Erect temporary fill barriers in the slice as required.

7) Erect a barricade at the entrance to slice 2WA.

8) Install extra support for the fill brow. three mudsills pin set in the wall or screen inter-threaded with 5/8 inch cable and anchored to the walls.

Pour procedure:

1) Use internal fill barriers(2) to pour five foot thick slabs(3) starting at hanging wall and retreating to main barricade at foot wall.

2) Discharge slimes and flush water into number 2 drift East and install control valves at 0023 cross-cut.

3) Monitor the line pressure at both the barricade and number one shaft. Do not exceed 700 psi and maintain communication with the surface pumpman.

4) Prohibit man access to number one shaft while pumping fill if the line pressure exceeds 100 psi.

5) Fill tight with high density fill.

6) Use air acceleration of the fill only if required.

7) Add retarder at an appropriate rate to the fill twenty minutes before a temporary shutdown.

8) Flush the line with water and air at the end of pumping.

APPENDIX "E"

In-Situ Monitoring (Started July 3, 1987 (3 dataloggers) - to continue until June, 1988)

Period:

July 3-August 14, 1987:	Datalogger number 1 was not operational. Reloaded memory, operating successfully since then.
July 3-September 8, 1987:	No mining in heading due to summer shutdown.
August 18, 1987:	Datalogger number 3 inoperable, was removed from stope and sent out for repairs to manufacturer.
September 9, 1987:	Mining of slice 2WB was resumed.
September 15, 1987:	First round under mat blasted; Young's modulus cell 207 was probably damaged at this point.
September 22-October 9, 1987:	Project on hold until relationship between datalogger readings and pressure were established. Datalogger value had to be multiplied by 100 before entering them into calibration curve.
October 15, 1987:	Mining re-started.
November 27, 1987:	Slice 2WB was mined out.

Table 3

Mining Progression from The Barricade

Date	Advance (ft)	Cumulative (ft)
September 11, 1987	13	13
September 15, 1987	14	27*
September 18, 1987	12	39+
October 18, 1987	12	51+#
October 22, 1987	12	63+#
October 28, 1987	12	75#
November 5, 1987	12	87#
November 10, 1987	12	99
November 15, 1987	12	111
November 19 1987	12	123
November 27, 1987	12	135

*: Young's modulus cells position
+: Convergence monitors position
#: Earth pressure cells position

Note: Besides mining cut 2WB, no other significant mining activity was going on in the vicinity of the test stope.

Table 4

Earth Pressure Cells Orientation

---

45 degrees inclination, perpendicular to the stope: cells number: 176, 177, 178, 185, 187, 204

---

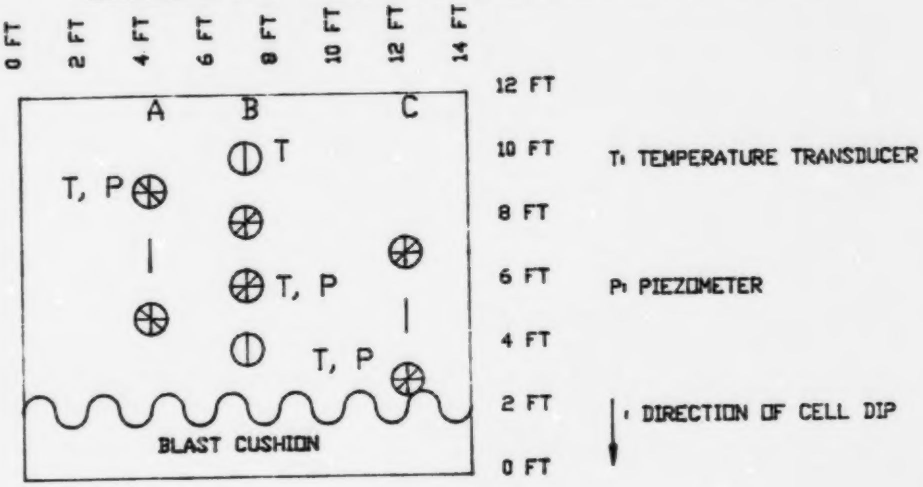
45 degrees inclination, parallel to the stope: cell number: 182, 183, 191, 192, 195, 202.

Vertical and perpendicular to the stope: cell number: 181, 200, 213, 214, 219, 221, 243.

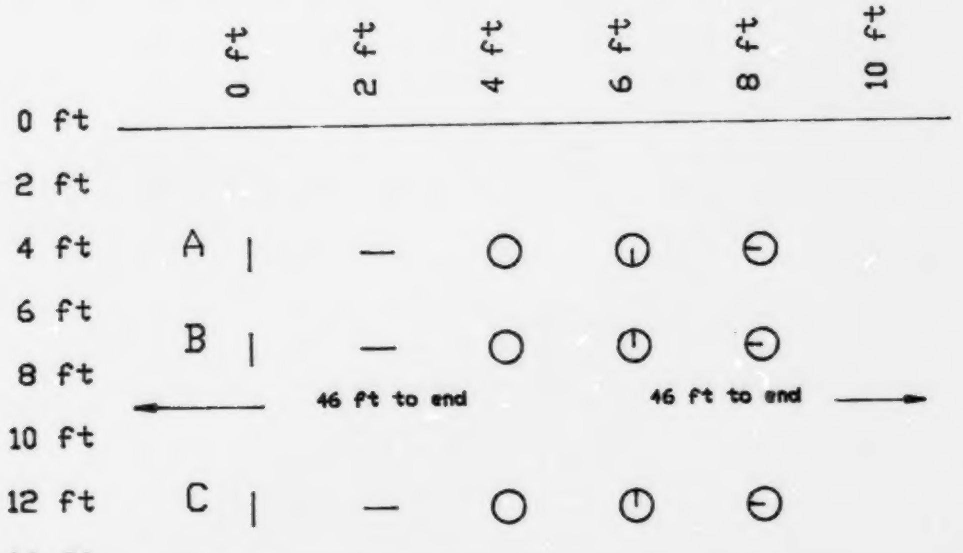
Vertical and parallel to the stope: cell number: 179, 188, 194, 201, 203, 205, 206, 215, 216, 217.

Horizontal: cell number: 180, 184, 189, 190, 198, 199.

FIGURE 7 PRESSURE CELL LAYOUT

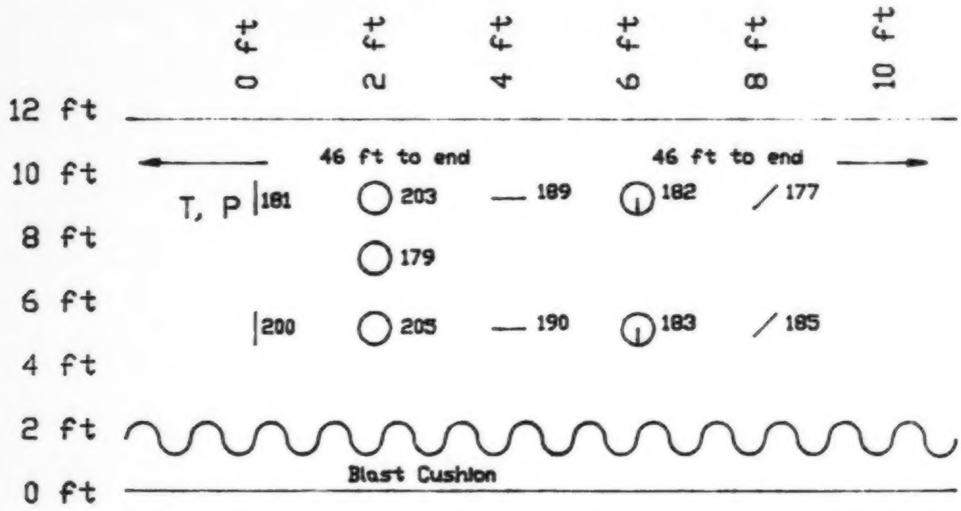

0 FT
2 FT
4 FT
6 FT
8 FT
10 FT
12 FT
14 FT
A
B
C
T
T, P
T, P
T, P
BLAST CUSHION
12 FT
10 FT
8 FT
6 FT
4 FT
2 FT
0 FT
T: TEMPERATURE TRANSDUCER
P: PIEZOMETER
DIRECTION OF CELL DIP

CROSS-SECTION

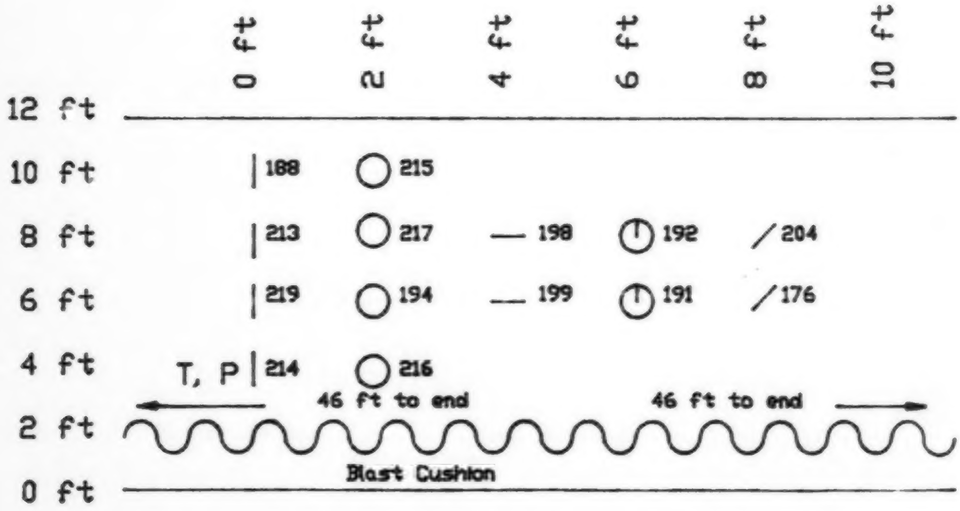

0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
12 ft
14 ft
A
B
C
46 ft to end
46 ft to end

PLAN VIEW

FIGURE 8 PRESSURE CELL LAYOUT

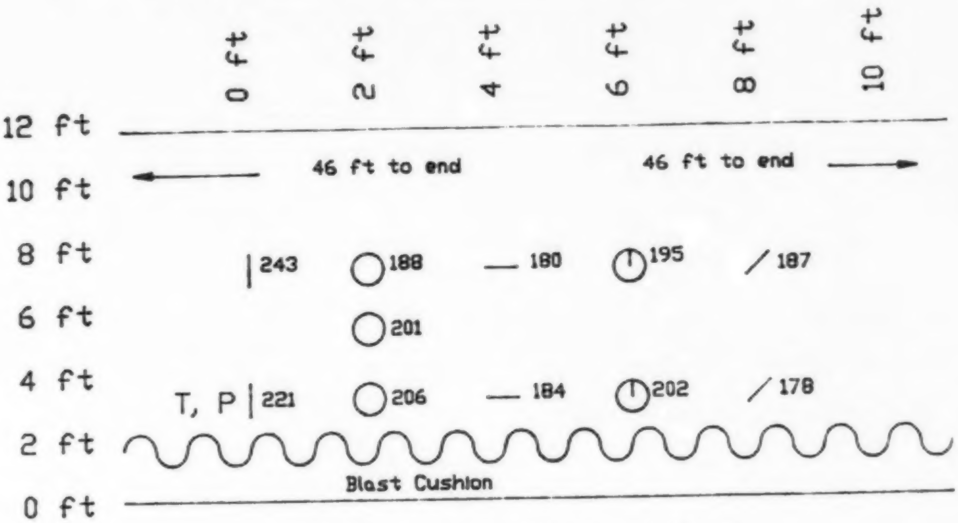

0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
12 ft
10 ft
8 ft
6 ft
4 ft
2 ft
0 ft
46 ft to end
46 ft to end
T, P
181
203
189
182
177
179
200
205
190
183
185
Blast Cushion

LONG SECTION LINE A


0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
12 ft
10 ft
8 ft
6 ft
4 ft
2 ft
0 ft
188
215
213
217
198
192
204
219
194
199
191
176
T, P
214
216
46 ft to end
46 ft to end
Blast Cushion

LONG SECTION LINE B

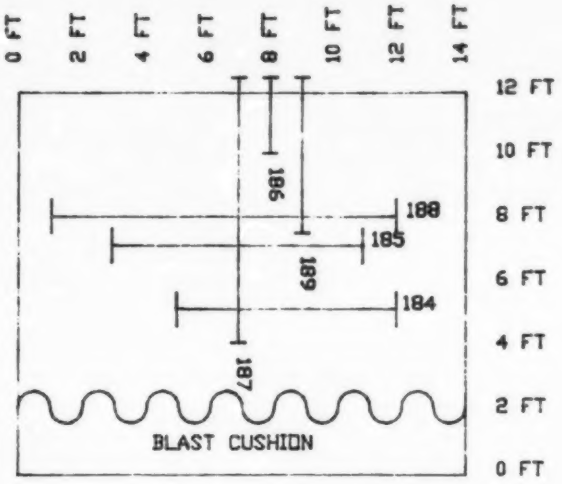
FIGURE 9 PRESSURE CELL LAYOUT


0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
12 ft
10 ft
8 ft
6 ft
4 ft
2 ft
0 ft
46 ft to end
46 ft to end
243
188
180
195
187
201
T, P
221
206
184
202
178
Blast Cushion

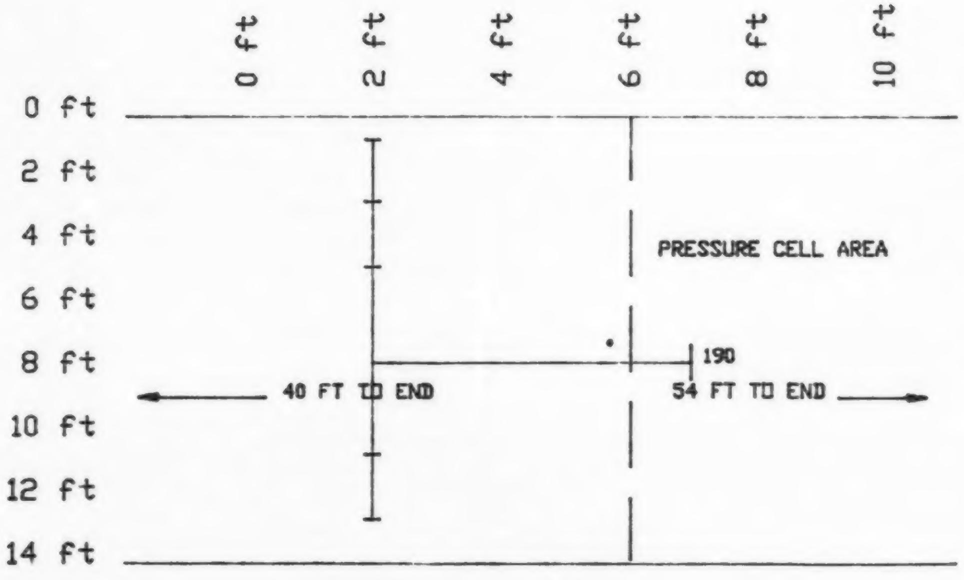
LONG SECTION LINE C

FIGURE 10

CONVERGENCE MONITOR LAYOUT


0 FT
2 FT
4 FT
6 FT
8 FT
10 FT
12 FT
14 FT
12 FT
10 FT
8 FT
6 FT
4 FT
2 FT
0 FT
186
188
185
189
184
187
BLAST CUSHION

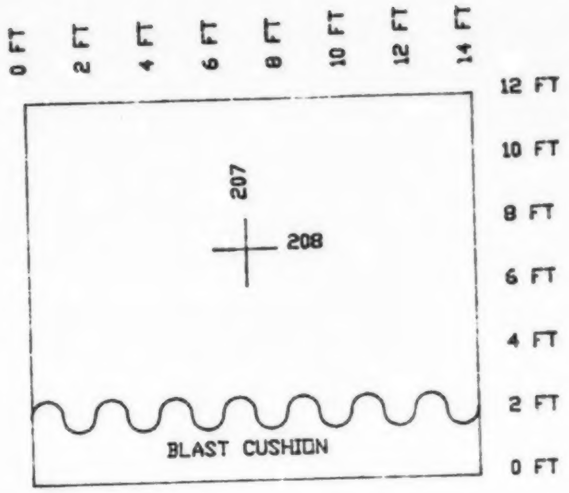
CROSS-SECTION


0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
12 ft
14 ft
PRESSURE CELL AREA
190
40 FT TO END
54 FT TO END

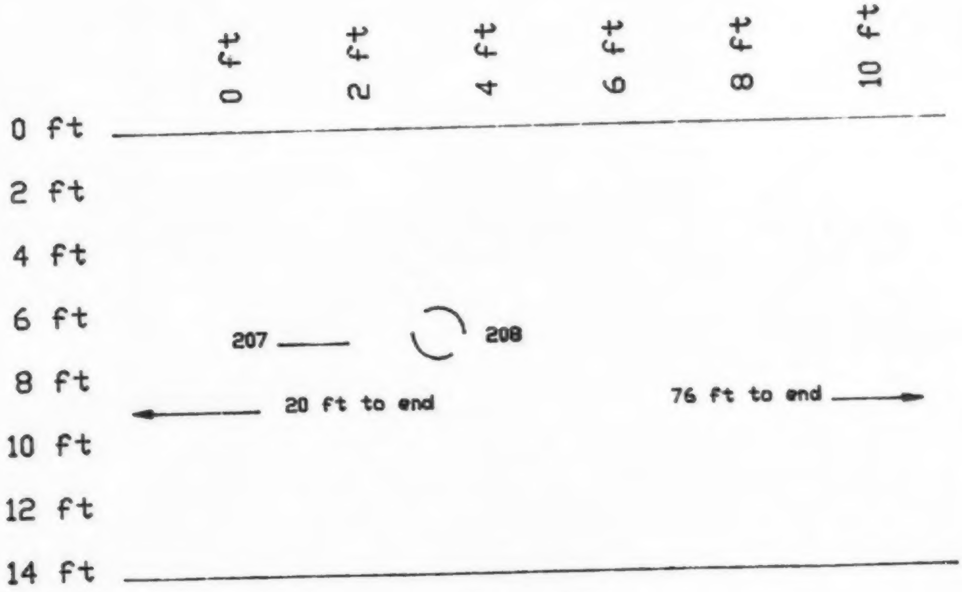
PLAN VIEW

FIGURE 11

YOUNG'S
MODULUS
CELL
LAYOUT


0 FT
2 FT
4 FT
6 FT
8 FT
10 FT
12 FT
14 FT
12 FT
10 FT
8 FT
6 FT
4 FT
2 FT
0 FT
207
208
BLAST CUSHION

CROSS-SECTION


0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
12 ft
14 ft
207
208
20 ft to end
76 ft to end

PLAN VIEW

APPENDIX "F"

Beam Theory Calculations

If a simple beam with uniformly distributed load is assumed, then from theory :

$$Mx = \frac{wx}{2}\,(l-x)$$

where w = load applied on the beam
l = span of the beam
x = any given position along the span of the beam.
M = applied moment on the beam

The span (l) of the beam will be equal to the width of the stope (e.g. 14 ft).

w = unit weight of the fill mass x height of the stope x 1 ft thick section

w = 137.2 lbs/c.f. x 12 ft x 1 ft = 1646.4 lbs/ft

From the flexure stress theory, assuming that the neutral axis of the beam is situated at mid-height of the fill mass (figure 14).

$$\sigma = \frac{2Fc}{6ft \times 1ft} \qquad M = 2 \times 2/3\ (6ft)\ Fc$$

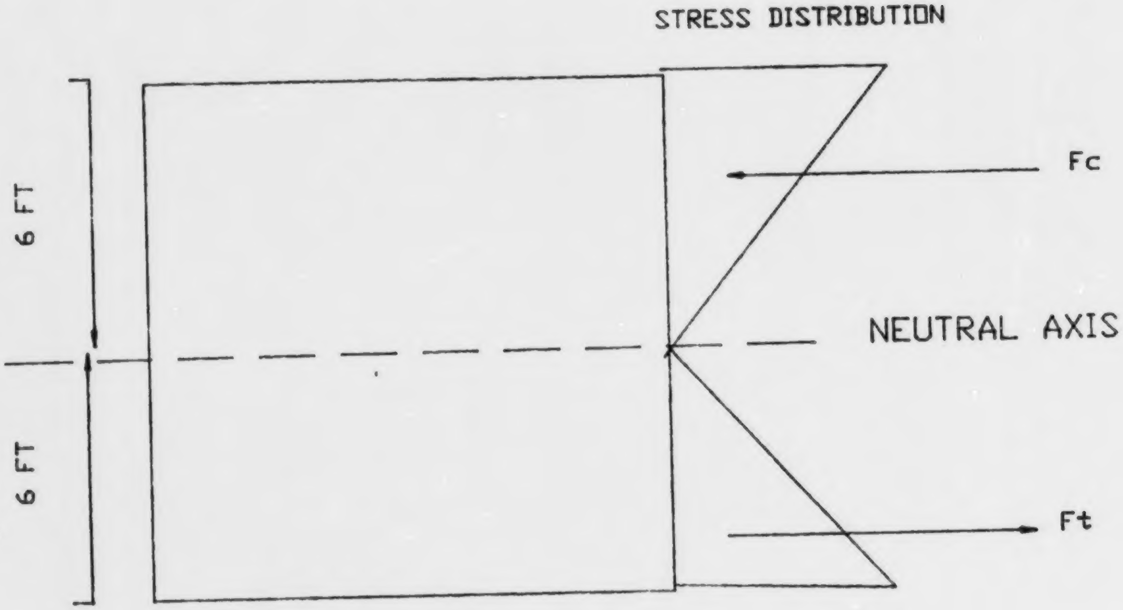
and $Fc = 3\ ft^2 \times \sigma$ therefore $M = 24\ ft^3 \times \sigma$

where σ = the fiber stress
Fc = the applied force

Thus $Mx = 24\ ft^3\ \sigma x = \frac{wx}{2}\,(l-x)$ and $\sigma x = \frac{wx\ (l-x)}{48\ ft^3}$

for $x = 7$ ft, M is maximum and so is σ therefore

FIGURE 14 FLEXURE STRESS THEORY


STRESS DISTRIBUTION
Fc
6 FT
NEUTRAL AXIS
6 FT
Ft

$$\sigma_{max} = \frac{1646.4 \text{ lbs/ft} \times 7 \text{ ft} (14 \text{ ft} - 7 \text{ ft})}{48 \text{ ft}^3} = 1680.7 \text{ lbs/ft}^2$$

$$\sigma max = 11.67 \text{ psi}$$

Figures 15 and 16 show the pressures measured by the total earth pressure cells while mining. Using the following equations the principal stresses σ_1, σ_2 and σ_3 were calculated.

$$\sigma_n = \sigma_x \cos^2\theta + \sigma_y \sin^2\theta + \tau_{xy} \sin\theta \cos\theta$$

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^{\,2}\right)}$$

$$\tan 2\theta = \frac{2\tau_{xy}}{(\sigma_x - \sigma_y)}$$

e.g. for section line A at 9 ft high:

for $\theta = 0^\circ$ $\sigma_n = 982$ psi

$\theta = 90^\circ$ $\sigma_n = 353$ psi
$\theta = 45^\circ$ $\sigma_n = 549$ psi

$$982 = \sigma_x \cos^2 0^\circ + \sigma_y \sin^2 0^\circ + \tau_{xy} \sin 0^\circ \cos 0_o + \tau xz$$
$$982 = \sigma_x$$

$$353 = \sigma_x \cos^2 90^\circ + \sigma_y \sin^2 90^\circ + \tau_{xy} \sin 90^\circ \cos 90^\circ + \tau yz$$
$$353 = \sigma_y$$

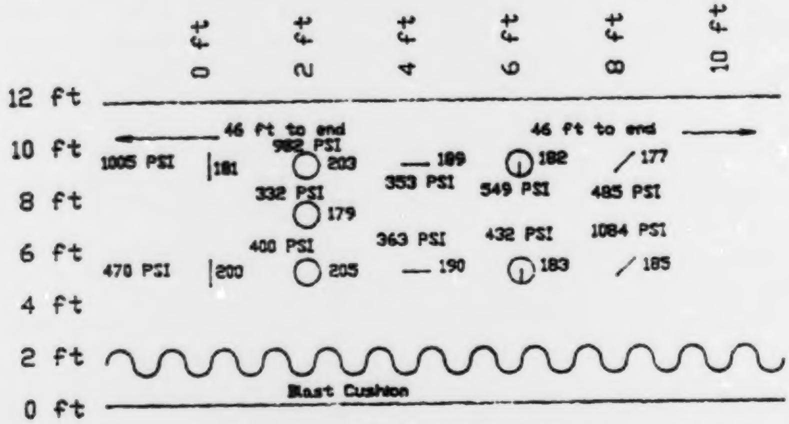
$$549 = \sigma_x \cos^2 45^\circ + \sigma_y \sin^2 45^\circ + \tau_{xy} \sin 45^\circ \cos 45^\circ$$
$$-118.5 = \tau_{xy}$$

$$\sigma_{1,2} = \frac{982 + 353}{2} \pm \sqrt{\left(\left(\frac{982 - 353}{2}\right)^2 + (-118.5)^2\right)}$$

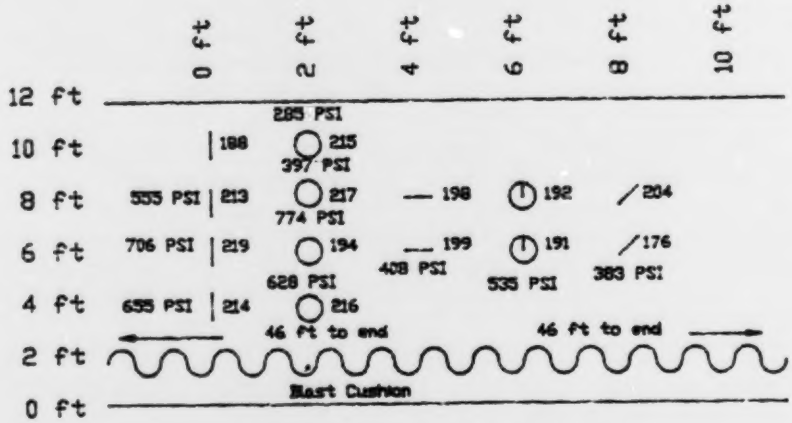
$\sigma_1 = 1003.6$ psi and $\sigma_2 = 331.4$ psi

$$\tan 2\theta = \frac{2(-118.5)}{(982 - 353)} \qquad \theta = -10.32^\circ$$

FIGURE 15 PRESSURE DISTRIBUTION

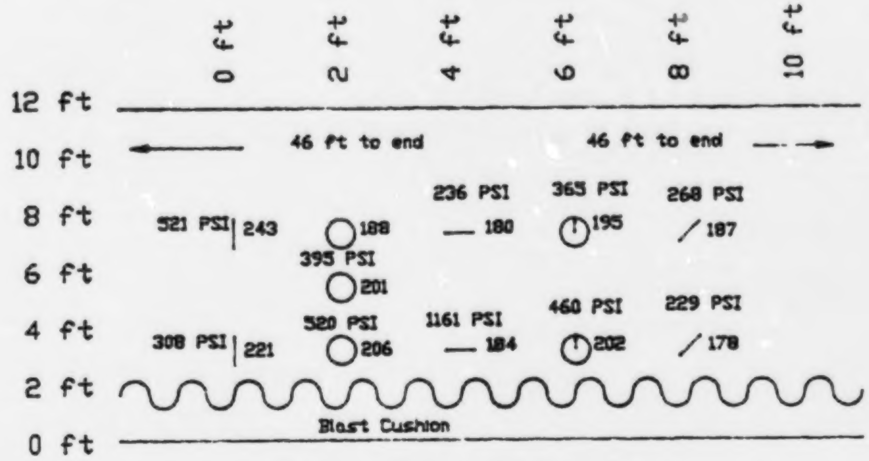

0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
12 ft
10 ft
8 ft
6 ft
4 ft
2 ft
0 ft
46 ft to end
46 ft to end
982 PSI
1005 PSI
181
203
189
182
177
332 PSI
353 PSI
549 PSI
485 PSI
179
363 PSI
432 PSI
1084 PSI
400 PSI
470 PSI
200
205
190
183
185
Blast Cushion

LONG SECTION LINE A


0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
12 ft
10 ft
8 ft
6 ft
4 ft
2 ft
0 ft
285 PSI
188
215
397 PSI
555 PSI
213
217
198
192
204
774 PSI
706 PSI
219
194
199
191
176
408 PSI
535 PSI
383 PSI
628 PSI
655 PSI
214
216
46 ft to end
46 ft to end
Blast Cushion

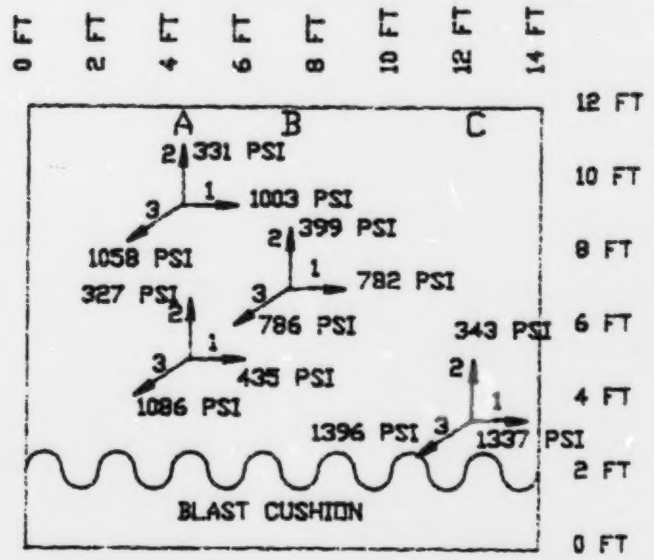
LONG SECTION LINE B

FIGURE 16 PRESSURE DISTRIBUTION


0 ft
2 ft
4 ft
6 ft
8 ft
10 ft
12 ft
10 ft
8 ft
6 ft
4 ft
2 ft
0 ft
46 ft to end
46 ft to end
236 PSI
365 PSI
268 PSI
521 PSI 243
188
180
195
187
395 PSI
201
520 PSI
1161 PSI
460 PSI
229 PSI
308 PSI 221
206
184
202
178
Blast Cushion

LONG SECTION LINE C

FIGURE 17 PRINCIPAL STRESSES LAYOUT


0 FT
2 FT
4 FT
6 FT
8 FT
10 FT
12 FT
14 FT
12 FT
10 FT
8 FT
6 FT
4 FT
2 FT
0 FT
A
B
C
2
331 PSI
1
1003 PSI
3
1058 PSI
2
399 PSI
1
782 PSI
3
786 PSI
327 PSI
2
1
435 PSI
3
1086 PSI
343 PSI
2
1
1396 PSI
3
1337 PSI
BLAST CUSHION

CROSS-SECTION

LEGEND: 1,2 AND 3 REPRESENT
THE DIRECTION OF PRINCIPAL STRESSES

APPENDIX G

LEVACK MINE

ORE BODY DESCRIPTION

The greatest concentration of copper-nickel sulfide mineralization in the North Range of the Sudbury Nickel irruptive occurs in the Levack Belt. This belt covers a stretch of ground extending in the west from Falconbridge's Hardy Mine to the Inco Big Levack property in the east, a distance of just over 5 miles.

Mineralization in the Levack Belt is associated with discontinuous zones of sublayer material which underlies the south dipping irruptive structure.

Levack Mine consists of 5 distinct but not necessarily separate orebodies. Mining at Levack is predominantly in the pillar recovery phase, with some 63 million tons having been mined from the deposit between 1914 and 1987.

The first of the 5 orebodies, the Main, extends from surface to 1600 level and has an approximate strike of N50°E and a south dip of 45° with little or no plunge. The ore zone attains it's maximum dimension east of #1 shaft on 700 level where the strike length is 1550 feet and width is 850 feet. The copper nickel sulfides are closely associated with a variable width granite breccia unit (0 to 250 ft.). On the west flank of the Main O.B. embayment a zone of ore bearing "peridotite breccia" occurs and is up to 50 feet wide. In the eastern section of the Main orebody, the sulphide has invaded a megabreccia and gives rise to large scale effects with the mineralized megabreccia extending up to 600 feet in depth and 450 feet in width. Brecciation varies from intense to very weak with the sulphide stringers occurring in random fashion.

The Cu/Ni ratio is in the range of 0.60 to 1.00 although throughout the orebody it is very erratic. Precious metal values are low and reflect the low orebody copper and the Po/Ni ratio averages 17.4.

Eleven hundred feet east of the Main is the #1 orebody which is connected with the number 2 orebody on 1200 level. It is an oval shaped ore zone and lies between 0300 and 1200 levels. It strikes 045° and dips 45°E. The sulphides occur within thin (less than 80') granite breccia sheets above 1200 level which thicken to 600 feet below 1200 level.

Between 1400 and 1500 levels the norite flattens to horizontal for approximately 600 feet while the sulphide & granite breccia maintain a constant dip and therefore project into the footwall.

The Cu/Ni ratio is 0.50 and as opposed to the Main orebody the predominant rock type is diorite and not granite gneiss.

The #2 orebody lies between 0300 and 2050 levels some 400 feet east of #1 orebody. The orebody dips 60°S and is truncated to the east by the Fecunis Lake Fault.

The sulphides are associated with a thin sheet of granite breccia which wraps around the norite embayment.

The Cu/Ni ratio is 1.74 and the predominant rock type is diorite.

The #3 orebody is a bulbous ore zone which lies below 1 and 2 orebodies from 1750 to 2650 levels. It is bounded by the Fecunis Lake Fault to the east. The ore strikes 075° from 700 to 800 feet and dips 45°SE.

The mineralization consists mainly of massive sulphide stringers in contact with large (100') granite gneiss blocks.

Two distinct ore zones can be identified within 3 orebody and are summarized below.

FW ZONE	HW ZONE
a) planar, thick (>10') massive sulphide stringers.	a) stockwork of narrow (<10') massive sulphide stringers.
b) Cu:Ni ratio of 0.85.	b) Cu:Ni ratio of 0.50.
c) lower zone.	c) upper zone.

Number 4 orebody is bounded on the east by the norite contact and the Fecunis Lake Fault on the west. The orebody tops at just above 1600 level and bottoms just above 3600 level.

There are three distinct zones of mineralization:

i) Granite Breccia Zone,
ii) Granite Gneiss Zone,
iii) Footwall Copper Zone.

i) The mineralization within the granite breccia zone is disseminated to massive disseminated nickel-rich sulphide. The Cu:Ni ratio ranges between 0.10 for massive sulphide to 1.00 for weakly disseminated sulphide.

ii) The granite gneiss and footwall copper zones strike 085° and dip 35°SW. This lobe consists of massive sulphide stringers protruding from the granite breccia into the larger breccia zone. This lobe has been faulted on its westerly side by the Fecunis Lake Fault. The granite gneiss zone apart from the host is identical to the granite breccia zone.

iii) The footwall copper zone is the down-dip extension of the granite gneiss zone. The sulphide is as massive stringers in sharp contact with the host granite gneisses and diorites. The sulphides are copper-rich and in places are massive chalcopyrite.

STRUCTURES

The three dominant structures of Levack Mine are the Hangingwall Shear, the Fecunis Lake Fault and the Auxiliary Fault.

HANGINGWALL SHEAR

The Hangingwall Shear strikes 295° and dips 45° south along the general trend of the norite contact. It is a 2 to 40 feet wide chloritic, carbonaceous, schistose zone. The zone has been identified in the hangingwall of the Main, No. 1 and 2 Orebodies and below the Fecunis Lake Fault above No. 4 Orebody.

The Hangingwall Shear can cause ground control problems as exemplified by the extensive caving in the hangingwall of No. 1 Orebody.

FECUNIS LAKE FAULT

The Fecunis Lake Fault strikes 345° and dips 70° west. It is a well healed, mylonitic zone varying in width from 1 inch to 15 feet. Pervasive hematization is associated with the fault zone up to 100 feet into adjacent rocks.

Copper to nickel ratios and orebody mineralogy suggest that No. 3 Orebody and the footwall protrusion of No. 4 Orebody into the megabreccia have been offset by the Fecunis Lake Fault. The above also applies to No. 2 Orebody and the granite breccia zone of No. 4 Orebody. The suggested movement for the Fecunis Lake Fault is 700 to 800 feet vertically and approximately 1600 feet horizontally for a net slip of about 1800 feet. This movement has been confirmed by the displacement of the Hangingwall Shear.

Stopes mining in the vicinity of the Fecunis Lake Fault have encountered unstable ground and in some cases overhand mining methods have had to be converted to undercut methods due to ground falls or excessive overbreak. It has been recognized in Diamond Drill core and site inspections that ground conditions along the fault are variable. In some cases, the shearing is extremely pronounced and extends out from the fault up to 100 feet. In other areas, the shearing is much less pronounced to non-existent. There is no evidence of any current movement along the fault.

AUXILIARY FAULT

The Auxiliary Fault strikes 330° and dips 50° south. It is a splay fault from the Fecunis Lake Fault and has a local affect on No. 4 Orebody. The Auxiliary Fault is a narrow zone (1 inch to 1.5 feet) of gouge with 50 to 60 feet of displacement. No major mining problems attributable to the Auxiliary Fault have been recognized.